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SUBJECT:

A REVIEW OF MODERN METHODS OF ROADBUILDING AS EXEMPLIFIED IN
MARYLAND AND MORE PARTICULARLY IN MONTGOMERY COUNTY.

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A Review of Modern Methods of Roadbuilding as Exemplified in Maryland and More Particularly in Montgomery County.

In treating this subject the writer will consider more particularly the recent advances, along the line of securing a comprehensive and adequate system of State and County highways, which have been the result of continuous and persistent effort in this direction by certain individuals as well as by the people at large.

Historical.

Until a comparatively recent date, about 1898, the State government had not given the subject any particular attention. In that year an act was passed creating the Highway Division of the Maryland Geological Survey. It was assigned as the duty of this Division to investigate the ^{road} materials of the State and, when requested, to furnish the counties with estimates and expert advice on road matters. In 1904 the present State Aid Law was passed, providing for an annual appropriation of \$200,000, which was to be distributed among the counties on a pro rata mileage basis. By the provisions of this law the counties could secure their allotment, only by the appropriation of an equal sum, which should be applied to some pre-determined road or roads, the plans for whose improvement were to be prepared by the said Highway Division of the Geological Survey. The Chief Engineer of the Survey became also the Chief Engineer of this Division. For the first few years the construction under this Act was confined to the building of short stretches of so-called experimental roads in certain of the counties whose Boards of Commissioners were progressive enough to recognize the advantage of providing object lessons

to their people of the modern macadam road, to be compared with their existing earth roads, rough stone roads and toll pikes. This was the means of creating a demand, at first slow, but later insistent, for more of this class of roads. There were of course many criticisms of the new type of road, both as to first cost, methods of constructions and maintenance, some of which were, and some of which were not, well founded. These were however probably no more numerous than those directed toward any other new form of endeavor when that endeavor is sponsored by the government. It may be noted that the only observable effect of this agitation was an increasing demand, on the part of the public, for more appropriations for this character of work.

In answer to this demand succeeding Legislatures continued and enlarged the appropriations, and finally, in 1908 the first State Road Law was passed, creating a State Roads Commission of six members, and authorizing a bond issue of \$5,000,000.00 for the construction of a system of State Highways connecting the county seats and converging toward Baltimore. It is interesting to note that the previous services of the members of the Geological Survey were appreciated, as three of its members were designated by the Act, as members of the State Roads Commission. The remaining three were made up of the Governor and two others appointed by him. This Commission promptly elected the Chief Engineer of the Geological Survey to serve also as their Chief Engineer, thereby in a measure combining the State Aid department and the State Road department. The Commission immediately took the task of selecting, as required by the Act, a system of roads to be improved as State Roads. These roads when finally improved were to be maintained solely at the expense of the State as a whole.

After visiting every County in the State and holding numerous hearings of advocates of various roads, the Commission selected a system aggregating twelve hundred miles. It may be here noted that this exceeded by some six or seven hundred miles, the probable number that could be constructed under the bond issue provided. This fact witnesses the conviction of the members of the Commission that the building of roads by the State would not be discontinued at the exhaustion of the original appropriation; which opinion has since been justified.

The remainder of the year 1908 was occupied chiefly with the survey and the preparation of plans for a number of sections of road in every county. One contract was let in the fall of that year. In 1909 the actual work of road building began in earnest. Numerous contracts were let and in some cases the Commission undertook work on a force account basis.

The General Assembly of 1910 transferred the road work of the Highway Division of the State Geological Survey to the State Roads Commission. This included all State Aid work as well as the construction of State Road No. 11 which was to connect Baltimore and Washington, and whose construction was authorized in 1906 and 1908. The membership of the Commission was also in this year, 1910, increased to seven, the additional member being an appointee of the Governor. The work has been continued under the above organization up to the present time. An additional appropriation was made by the General Assembly in 1912 aggregating \$3,000,000., most of which was however designated for application to special roads. As provided however in the original Act the bonds of the first \$5,000,000. were to be issued only \$1,000,000. a year, making the final issue available in the year 1913.

In Montgomery County the work of improving and maintaining the roads has been for a number of years directly under the Board of County Commissioners and until recent years no concerted effort has been made to secure a well defined system of improved modern roads. It is true that there have been spasmodic attempts at stone road construction but with no very satisfactory results. As an example of this may be cited the road leading from the County seat to Washington. Some twenty years ago this road was graded and a macadam surface laid upon it. The lack of systematic maintenance has resulted in reducing what was at that time considered a good road to what is now the inferior of many of the existing rough toll pikes of the County. Toll pikes have been constructed from time to time to meet the demand for something better than earth roads. In former times these answered their purpose as well as could be expected but through the gradual education of the public to expect the roads to be passable and kept so at the expense of the County, toll roads have come to be considered highly undesirable and in many cases have been acquired by the County, special bond issues being assessed against certain districts to pay the owners.

This County first entered upon the construction of the recognized modern macadam road in 1905 when it first availed itself of the provisions of the State Aid Law to which previous reference has been made. Since that time the County has constantly availed itself of its full allotment under this Law and under the influence thus brought to bear, has progressed in the matter of roadbuilding. In 1910, following the example of numerous other Counties in the State and to some extent following the plan proposed by the Highway Division of the State Geological and Economic Survey, a Law was passed by the General

Assembly providing for the appointment by the Commissioners of a Road Superintendent whose duties and powers will be later discussed. Since that time, in response to the growing demand for better roads which has developed throughout the State hand-in-hand with the development of the State organization, more and more attention and money has been devoted to this enterprise. By an Act of 1912 the General Assembly further increased the efficiency of the Road Superintendent by enlarging his powers and it seems probable that eventually both the public and the County Commissioners will come to realize as in many other places has already been realized, that the greatest efficiency and economy are to be secured by the complete separation of the administration of road affairs from political influences and the entrustment of them, as with other technical matters, to those who may give them their complete time and attention unhampered or biased by political considerations.

Administration

In the following discussion the Administration, Financing, Methods and Kinds of construction and maintenance of both State and County roads will be considered separately or in conjunction as they bear upon each other.

State Road Administration.

It may first be well to consider the methods of administration now in force by the State Commission.

State Roads.

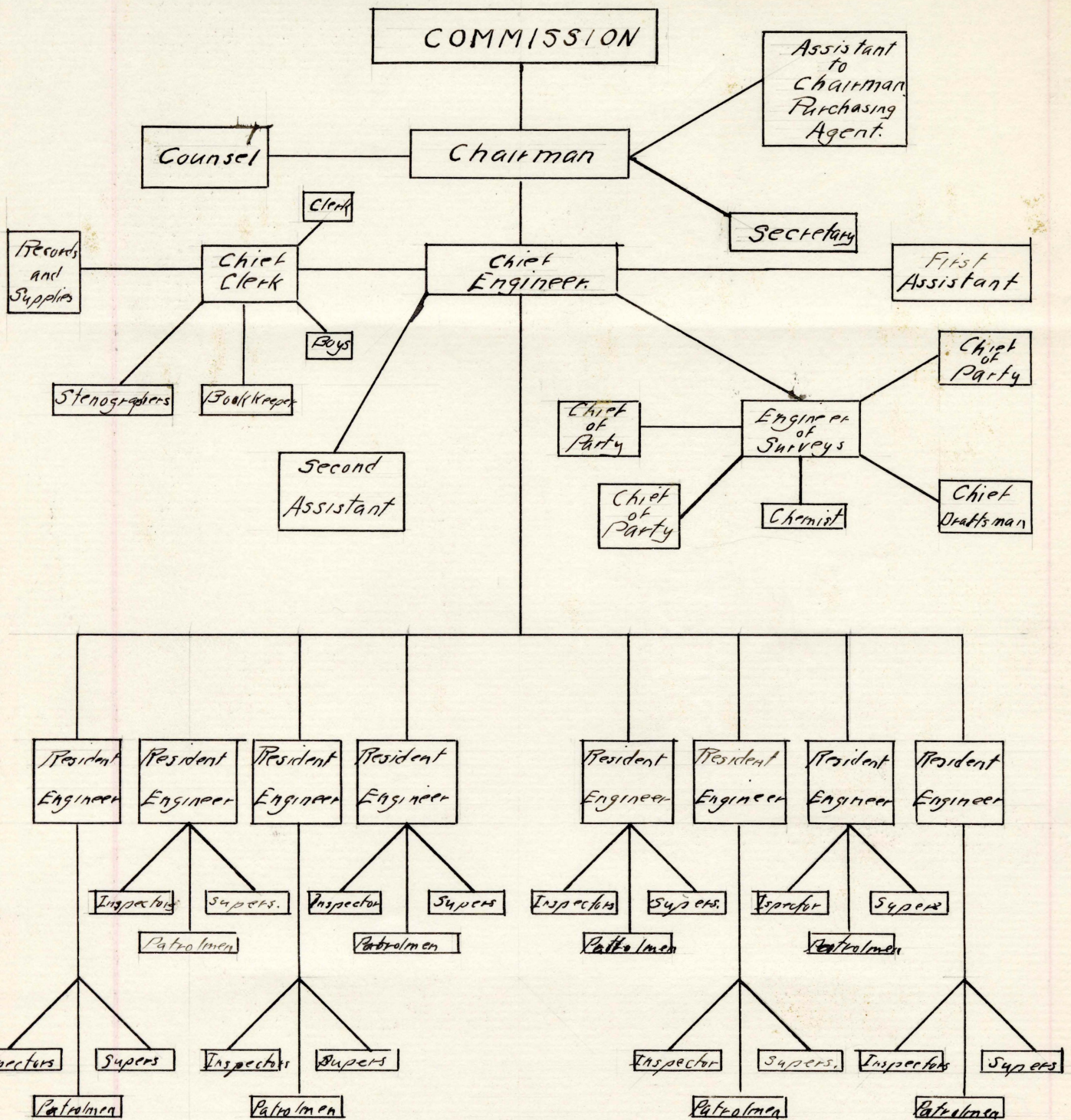
The Maryland State Roads Commission at present consists of seven members, three of whom are members of the Maryland Geologic and Economic Survey, one is the Governor and the remaining three appointees of the Governor for terms of four years. The first four serve without compensation other than that which they receive in their other capacities. One of the

appointed members is designated by the Governor as chairman. The Commission maintains its own office force for clerical matters consisting of a secretary, stenographers, bookkeepers, etc., and have a counsel.

The Chief Engineer is appointed by the Commission for a term of four years. The Chief Engineer is in direct control of all construction, maintenance and surveys subject to decision of the Commission with reference to matters of policy, location and to some extent, kinds of construction. Under the Chief Engineer are, the first assistant, second assistant, engineer of surveys, chief clerk and the various resident engineers who in turn control the minor units of the organization. The accompanying diagram, the data for which was furnished by Chief Engineer Shirley probably shows the scheme of organization better than it could be described. An inspector is maintained on each contract while work is in progress.

State Road work in this County is at present performed entirely outside of any County control. Until October 1912, Montgomery County has been performing this work by what was termed extraordinary force account under an agreement with the State Road Commission whereby certain changes were made in the State specifications where it was deemed advisable by the County Road Superintendent, that work being directly under his control. The County simply acted as a contractor without compensation and in addition furnished the services of their Road Superintendent free of charge. This was done in the belief that one familiar with local conditions such as stone, grades, etc., would lessen the cost, improve the quality or both by not adhering strictly to specifications, more or less standardized for a number of localities.

The writer was employed by the County for the State on work of this kind from September 1910 to October 1912, assist-



Scheme
of
Organization
of the
Maryland State Roads Commission.

ing that time on about twelve miles, and is of the opinion that the County's contention is in most cases sound. It is a fact however that the reported cost of some roads built under this method has nearly or quite equaled the estimated cost of contract work, but it is the writer's opinion, borne out the recorded facts, that a fair investigation of the records showing the quality and quantity of local stone used would show amounts far in excess of that used by a contractor under the square yard basis in force under the State Specifications.

This arrangement has at present been arbitrarily terminated by the State Road Commission and is at present the subject of contention with them by the County.

County Road Administration.

In Montgomery County the administration of road matters is in the hands of the Board of County Commissioners who are elected by the whole County for terms of four years. Until 1910 these Commissioners had both general and direct control of all matters relating to the location, repair and maintenance of all roads. In that year the General Assembly passed a Law providing for the appointment by the Commissioners of a Road Superintendent, and made certain changes in the existing scheme of administration, which Law was further amended in 1912 and is now in operation.

The Road Superintendent is appointed for a term of four years. The Commissioners may employ such assistance for him as they deem necessary in the way of inspectors, office or field assistants. As yet no definite, permanent organization has been established, the Superintendent employing such assistants as he may need on special work, such as permanent improvement of roads or the construction of bridges. It is the duty of the Road Superintendent to recommend repairs and

improvements to be made and to submit to the Commissioners plans and estimates for such improvement. Also he submits any plans and estimates for road improvement which the Commissioners may request of him. He also must review and make recommendations on all contracts for construction and maintenance of roads and bridges, as well as, for the purchase of machinery, and the Commissioners may not depart from these recommendations except on majority vote of whole Board. When such departure is made a definite reason must be assigned for it, and the same must appear in the minutes of the Board. This provision has the effect of restraining the Board from giving contracts for political or other reasons, which would not bear inspection in the minutes, which are at all times open to the public. It is also unlawful for the Treasurer to pay any bills for road or bridge work unless approved by the Road Superintendent; unless so ordered by a majority vote of the Board with attached reasons for disregarding the said disapproval. This provision has been found to be excellent in preventing the haphazard passing of bills without inquiring into the value received for their amounts. The Road Superintendent has the power to suspend work on any contract when in his opinion it is not being properly performed; subject however to review at the next meeting of the Board. It is duty to submit a plan for maintenance of all County roads but its adoption rests with the Board. Before February 1st of each year the Road Superintendent makes a report and inventory to the Board and shows amounts and costs of work done in previous years and also what tools and machinery are on hand. The Road Superintendent is required by law to be a member of all Commissions for opening roads or for assessing damages and benefits on any contemplated change or for establishing a road in the case of uncertainty as to its location.

Under the old method and still to a large extent the Commissioners each have more or less direct control of the roads in a certain district arbitrarily determined by them and called a Commissioner's district. This consists of several election districts there being thirteen election and five Commissioner's districts in the County. The method of care of the earth roads has been for each Commissioner to appoint a large number of road supervisors to attend short stretches of road, say two to four miles. This supervisor "worked" this piece of road once a year expending whatever amount of money his Commissioner allowed him. It was then the duty of the Commissioner to examine the road to determine whether the money had been properly applied. As the mileage of roads in this County is approximately nine hundred it may be noted what an amount of patronage was thus available for political purposes simply by the judicious apportionment of roads. In addition to this phase of the matter the actual methods vary with each supervisor while the of the performance of the work is made to suit his convenience rather than the needs of the road. The writer has frequently seen earth roads which have been subject to the winter traffic, allowed to take care of themselves until August, their degree of passability depending solely on the traffic and varying directly with the volume of it. At that season these roads were "repaired" by one of the numerous methods in use by the supervisors and perfunctorily inspected by the Commissioner whose actual knowledge was in many cases inferior to that of the supervisor. In the course of a few weeks under the influence of a spell of rainy weather, common at that season and the heavy fall farm traffic the road had regained its former condition to remain that way in varying degrees of roughness for the ensuing eleven months.

This method of the administration of the maintenance of earth roads is unfortunately in force yet in a majority of the districts of the County and it is obvious that the Road Superintendent can do little to improve conditions while handicapped by it. The reasons for its continuance by the Commissioners are obvious.

After considerable effort it has been possible this year to secure the partial adoption by certain members of the Board another method recommended by the Road Superintendent. This consists of employing a supervisor for a whole election district who will have charge of all earth roads in his district and although appointed by a Commissioner will report to the Road Superintendent on all work done and will follow methods suggested by him. This, it is expected will at least bring these methods to some degree of uniformity and will encourage good, practical men to take hold of this position and devote a large proportion of their time to it.

The method of administration of State Aid County work was in conjunction with the Highway Division of the Maryland Geological Survey and now with the State Roads Commission. The Commissioners advertise this work under State Specifications and let it subject to approval of the State Roads Commission. This work is then performed by the contractor or in some cases by the Commissioners by force account under supervision of the State Roads Commission, maintained thru an inspector constantly on the job and an engineer inspector who makes frequent visits thereto. In such cases the Road Superintendent has control for the Commissioners.

Financing.

The matter of financing is possible the subject of as much consideration as the actual work itself. This is necessarily so, as all work must of course be preceded by some

provision for meeting the cost. It is probable that no branch of actual construction requires the degree of diplomacy as that of the preliminary financing which of course includes as the first step, the passage of proper laws providing the legal methods.

In this County the methods of financing road work may be summed as follows:

1. General levy on whole county.
2. Special district levies.
3. Bond issues by districts or county.
4. Private subscriptions.
5. State Aid Law.
6. United States Government contributions for experimental and post roads.
7. Combinations of two or more of above methods.
8. Automobile Fund.

In addition to these is the State Road Bond issue, the taxes for which are levied according to assessment but as has been mentioned, is only applicable by the State Roads Commission and as they may direct.

General Levies.

The first of the above mentioned methods, General Levy, is determined when the yearly levy is made in June of each year. The Law provides that all districts be taxed equally for an amount sufficient to provide a sum sufficient for: (1) \$25. per mile for repair of all earth roads; (2) \$150. per mile for repair for all stone roads; (3) Sufficient to provide a bridge fund for all bridges and culverts which will probably be needed during the ensuing year; (4) Amounts necessary for the purchase of any considerable amount of machinery. (Small purchases are charged against the construction in question.)

The first two are distributed to districts according

to their mileage of each kind of road. They may not be diverted from these districts for any purpose whatever. Neither may they be used for any other purpose than that for which levied, except upon certification by the Road Superintendent, that the same ~~are~~^{are} not needed for repairs.

The bridge fund if of course used where in the opinion of the Commissioners the need is greatest and its use is not prescribed by law.

All money obtained by the County for franchises is required to be applied to the general Road Fund. From time to time special general levies are authorized and ordered by the General Assambly to apply to special purposes. There is also a surplus fund which is the repository of all excesses of levies for other purposes in the County. This may under certain conditions be applied to permanent improvement of roads.

District Levies.

The second method, that of special district levies, allows the Commissioners to place upon single districts small special levies for one year, the proceeds to be used for permanent improvement only within their district. The amount of this usually does not exceed ten cents on the \$100. of taxable basis.

By permanent improvement is meant the construction of macadam roads, the grading of roads, the relocation and opening of roads, or the construction of bridges, the cost of which is too large to be borne entirely by the bridge fund.

Special Bond Issues.

The method of Special Bond Issues provides for the issuance of bonds for a term of years for special purposes. Unless ordered by the legislature these bond issues must be voted on in the district to which applied by the taxpaying

voters at a special election which the Commissioners may call. Such an election may be called only after the presentation to the Commissioners of petitions signed by a sufficient number of taxpayers to make it evident that such an improvement is generally desired. Such bonds may not be issued except in series not for a term of more than twenty-five years and levies are made on the districts effected for amounts sufficient to redeem one bond each year. This method provides an equitable method by which progressive districts may improve their roads without encountering opposition of districts composed of a less progressive element. In cases where roads lie in extreme portions of districts, thus making the result of an election doubtful, but where the road is evidently an important one, the General Assembly provides by special Act for each instance for the issuance of bonds without the referendum clause.

Private Subscriptions.

The fourth method, that of private subscriptions, simply gives the Commissioners power to accept such subscriptions and apply them as intended. This, however, is usually applied in conjunction with one of the other methods, and the payment of these subscriptions is often made a condition on which the other money is to be raised.

State Aid.

The fifth method, State Aid, provides for the distribution to the counties in amounts proportionate to their mileage of a sum appropriated annually by the State for this purpose. This is always on condition that the County applies an equal sum and that the construction is, as has been mentioned under supervision of the State Roads Commission.

United States Government Appropriations.

The sixth method, is one of special arrangement only

and has lately been applied to about ten miles of road in this county. The United States Office of Public Roads having some money to be used for experimental purposes and desiring to use some of it adjacent to Washington arranged with the County to appropriate certain amounts approximating twenty-five per cent of the cost while they would furnish the remainder for certain roads leading out of Washington. Under this arrangement the United States has complete control of construction and maintains the roads for a period of ten years.

The seventh method, that of combination, is described by its name.

Automobile Fund.

The eighth method provides for the distribution to the counties of such proportion of the net revenue from automobile licenses as the sum of State Roads and State Aid Roads in each county bears to the total of the same in the State. The proportional part of this sum applicable to State Aid Roads is turned over to the Commissioners on certification of Chief Engineer of State Road Commissioner to be applied only to State Aid Roads under supervision of the State Roads Commission.

This practically includes all methods now in force in this County for financing Road Improvement. Their number and variety is evidence of the attention devoted to road matters by law makers and officials.

Surveys and Plans.

Preceding practically all contemplated road work a survey of some kind is necessary. It may vary from only a cursory examination with only the roughest measurements, often made from maps, to a detailed survey showing exact conditions of the contemplated location. The first is often all that is needed where the County expects to undertake the work with its w

own forces. This method is employed in determining probable amounts necessary for bond issues. However, when a detailed estimate is desired or when excavation will be paid for at yardage prices, a careful survey must be made. The latter method is always followed by the State Roads Commission which maintains an organization for this purpose. The writer was employed on one of their parties for about a year and their method is given below.

The party consists of a chief, instrument man, and two rodmen, who are also chainmen. The chief has full charge of the party and keeps the main notes in the field. A random transit line is run along the old road and to this all topography, such as fences, houses, and bridges ~~is~~^{is} referenced. Stakes are offset at approximate right angles every hundred feet or oftener if the grade breaks in between. These stakes are placed at varying distances from the line, the object being to locate them where they will not be disturbed by construction. Transit points are of course accurately referenced and the chaining is continuous between them. Surface measurements are usually taken except on very steep grades. After a portion or the whole of the transit line has been completed the same party takes cross sections. These are taken at every stake and every drainage ditch. The elevation at the top of each stake is secured and the distance from the stake of each rod reading in the section is noted. Bench marks are established about every quarter of a mile. A line of check levels is always run afterwards, checking on each bench. Either true or assumed elevations are used and should check to one-tenth of a foot for about every three miles. Relocations are sometimes made by the party at this time if the need is apparent.

The plan, profile and cross sections are then plotted in the office from the notes thus obtained and a preliminary location made on the plan. This is made up into blueprints and given to an engineer inspector who goes over the road and with aid of the preliminary plans recommends any changes together with dimensions for all culverts and bridges. The Final estimates and grade sheets are then made up. On grade sheets grade points are indicated as distances out from, and above or below the original stakes which guide the location of the road by the inspector or superintendent. In case any considerable number of stakes are missing a party is sent out to reset them. Final sections are taken exactly as original sections and determine amounts of grading that has been done.

The speed of a party of four under average conditions is about one mile, of finished work per day, including transit line, cross sections and check levels. The Highway Division of the Geological Survey originally furnished the counties plans for roads at the lump sum of \$50. per mile. The cost of course varies with the character of the country but \$50. per mile is usually considered low for completed plans and estimates.

Methods of Construction.

The present methods of construction of all public roads in this county come under four heads as follows:

1. County Work.
2. State Aid Work.
3. State Work.
4. United States Government Work.

County Work.

County work may be considered as including all road

or bridge construction which is not specifically included under one of the other three heads.

Construction of this class is done by contract, force account, or a combination of both methods. Work in excess of \$500. cost is required by law to be advertised for bid. If in opinion of ^{Commissioners} ~~County~~ or Road Superintendent these bids are too high they may reject all of them and perform the work by force account, that is, purchasing materials and tools, and having superintendence of labor and teams. Work let by contract under County specifications may be grading, macadam, bridges, etc./ Grading when let by contract is paid for either at so much per cubic yard of excavation determined by cross sections or is paid for at cost plus percentage. The former method has the advantage of securing definite amount costs but it necessitates the making of careful surveys and in the case of light fills and intermittent side work on shoulders does not always present accurately a statement of work done. For this reason contractors are apt to bid high on a yardage basis for such work.

The method of cost plus a percentage has the advantage of eliminating detailed surveys and uncertainty as to amounts and the resulting in high yardage prices. It, however, presents the serious disadvantage of providing the unscrupulous contractor an incentive to increase the cost of work both by slowness and quantity of work. This of course necessitates the constant maintenance of an inspector and timekeeper on the job, and even then a contractor may pad his pay-rolls in ways which it is hard for the timekeeper to detect. The writer has been employed for several months on a job of this kind and has had some opportunity to observe work of this class.

Macadam construction when let by the county by contract is usually paid for at a fixed price per ton or per cubic yard of stone delivered, placed and rolled into a finished surface. When foreign stone is used original freight bills are accepted to determine weights. If the price is per cubic yard, the weight of a cubic yard is determined by weighing a struck load in a dump wagon. If local stone is crushed and used the County maintains scales and a weigher to determine amounts. Both of the above methods have the great advantage of presenting an accurate statement of exact amounts of stone used and are not dependant on the vigilance of an inspector to see that the proper depth is maintained as in the case payment is made per square yard of surface. Percentage work is sometimes resorted to on stone contracts where stone is distributed in small quantities at varying distances from the road. In such cases the stone is often not crushed and scales could not be conveniently located to weigh it. Bituminous surfacing is usually paid for at a fixed price per square yard.

Bridge work when done by contract is let sometimes by lump sum, sometimes at a price per cubic yard for masonry plus a lump sum for iron work, and sometimes as in the case of concrete structure, the price per cubic yard covers everything including excavation. All contracts allow excavation below a specified depth to be paid for on a force account basis as extra work. In the case of a number of concrete arch bridges the price per cubic yard of concrete has included backfilling over the arch after completion.

County work is often performed strictly as force account without the employment of a contractor. All of the above classes of work are so performed when it is deemed advisable. The County then purchases all equipment and material,

hiring foremen and labor thru the Road Superintendent. Small jobs that would not warrant a contractor giving reasonable bids are usually handled in this way.

Combinations of contract and force account are frequently employed. In these cases the main work may be contracted and special parts be arranged on a force account basis or vice versa. On one road over which the writer now has charge this method is employed. The work was let to a contractor to be paid for as follows:

Grading, shouldering, sub-grading, ditching, and culverts, at fifteen per cent.

Quarrying, hauling, placing and breaking by hand the first course, cost plus fifteen percent. All rolling of fills and first course to be done by County.

Second and third courses of macadam to be delivered, spread and rolled to a finish at \$1.97 per ton.

Concrete at \$7.50 per cubic yard.

Several bridges on this work were put in by County force account, contractor having no percentage profit on them.

The reason for doing the excavation by percentage work was, that it was of such uneven distribution and such variable hauls being largely shoulder work, that the contractor was unable to submit a satisfactory price on it. The first course of macadam was composed of boulder quartz obtained adjacent to the road at numerous places. This was given free to the County for use but the contractor would probably have had to pay for it. The cost of this in estimated quantities was about \$1.75 per ton for first two miles, completed to the present time.

State Aid Work.

State Aid Work is contracted for in any of the foregoing ways but in practically all cases the State Road Commission maintains an inspector to insure work conforming to their specifications. The usual method for this class of work in the past has been a fixed price per square yard for finished macadam of a specified depth, it being the duty of the inspector to see that that depth was maintained. This has probably been productive of more bad results in this county for this class of work than any other method. The prevailing low salaries paid by the State for inspectors made it impossible for them to secure experienced men who were unapproachable by the contractor. The writer knows of instances where macadam of less than two-thirds specified depth has been accepted by this means. The remedy is obviously to remove the temptation or to secure a higher grade of inspectors but so far the efforts of the State Chief Engineer to convince the Commission that money spent in efficient inspector's salaries is money well spent, seem to have been unavailing. The Tonnage method, which seems to be the other solution, is now coming into use.

Grading is usually paid for per cubic yard of excavation determined by cross sections made by State Office. Culverts have a fixed price varying with size. Concrete is paid for per cubic yard. Force account State Aid work is conducted similarly to the County Force account, either by the County or a contractor. In the latter case the contractor of course gets a percentage profit.

State Road Work.

State Road Work has been handled by one of the methods of State Aid Work or by what is known by the State Road Com-

missionas extraordinary force account. The writer was employed by the County for the State on extraordinary force account of this kind for over two years and it may be well to describe this more fully. As mentioned before this agreement was made with the County by the State Roads Commission at the request of the former in the belief that more and better roads could be constructed from the County's allotment of State funds if thru the means of local knowledge, unessential grading and refinements were not adhered to and in the local available stone was used. The "Extraordinary" feature of this force account work was that the County authorities thru their Road Superintendent were given carte blanc to build the road according to their own ideas regardless of the State Roads Commission's Specifications, with the following limitations: (1) the macadam should be fourteen feet wide; (2) it should be eight inches thick after rolling; (3) the roadway was to be twenty-four feet wide on fills, twenty-two feet in cuts, and ⁽⁴⁾ no grade should exceed eight per cent. Practically the same arrangement was also made with a member of the State Road Commission itself who was from this County and who undertook to build a section of road under his own personal supervision.

In order to carry on this work in this way the State Road Commission purchased for use of the County but out of this County's allotment of State Funds a complete equipment for roadbuilding purposes which had the capacity of turning out about six miles of work in the working season from April 15th to December 15th. This consisted of four ten-ton rollers, four water wagons, two complete one hundred and fifty tons crushing outfit with engines, thirteen dump wagons, two road machines, several wheel and drag scrapers and various tools totaling during the two years of operations an expenditure of about \$30,000. Teams were either hired locally or from a hauling contractor and sometimes the hauling of stone was

subcontracted at a yardage price. Quarries were opened when available and contiguous to the road to be built and during the winter months as well as during the working season these were operated, to supply stone for the contemplated work. When quarries were not available stone was obtained from boulders and field^{stone} which were found on adjacent farms. In most cases stone was contributed free by the owners as they realized that by so doing they were not merely putting money in a contractor's pocket but increasing the mileage possible from the State's allotment, in addition to the advantage gained by having the farm cleared. The crushing plants were entirely portable and were moved from time to time as the haul to and from the crushers became too long.

All stone used was weighed, first, in order to pay for its hauling, second, in order to present to the State Road Commission an accurate statement of exact amounts used. By this means it was proved on one job of which the Writer had charge that the County had put on the road forty-two^{hundred} tons of stone per mile against four thousand tons required by agreement with the State Roads Commission, and three thousand tons usually used by contractors for a fourteen feet, eight inch road paid for by a square yard price.

The quality of stone used for surfacing was in most cases far superior by actual test to the limestone commonly used by contractors. Limestone not occurring in this county the stone used for the surface course was some variety of gneiss or in one case the common boulder traprock. Being harder than limestone, this stone required a corresponding increase of rolling for a smooth water bound macadam which was approximately from two to four times the amount usually necessary. The corresponding increase in length of wear was believed to justify this increased cost. The depth of stone

was varied somewhat to suit the character of the soil and in at least one case an existing old pike was used as subgrade, sufficient first course only being used to bring it up to the proper shape for the placing of the second or surface course. In the above case quartz was used thruout, the proper bound being secured by scattering small amounts of clay over the stone.

Grading was largely eliminated, only so much being done as was absolutely necessary to secure proper drainage, together with the reduction of grades exceeding eight per cent, and the removal of sharp irregularities. No method of securing the exact amounts of grading were available to the County except thru the State Roads Commission's cross sections which are not accessible at present time to County authorities. In all cases, however, it is known that a reduction in quantities was secured without unsightly final appearances and with practically no diminution of the utility of the finished road. In most cases the alignment of the old road was adhered to, but where relocations were obviously desirable and necessary they were made.

In addition to the above advantages, considerable additional benefit was derived by the localities affected by the distribution of a large proportion of the cost of construction in the immediate community in the form of team and labor hire which benefit would not have been so apparent had a contractor's forces been employed. The final cost of roads by this method has ranged from \$8,000. to \$11,000. per mile which in view of the results, methods and class of construction the County does not deem excessive. In cases where this amount could have been equalled or lessened by contract work, it is thought that the quantities and qualities of the stone would not have been the equal of those used.

United States Government Work.

The fourth of the general methods of construction in the County is that of work done by the United States Government. There is in the County one road which is strictly a Government road and which altho it runs thru the County is not in any way under the County's control. This is what is known as the Conduit Road, built over the conduit carrying Washington's water supply from the Great Falls of the Potomac to the city's reservoirs. This road follows the river and was built and is maintained by the United States Government on a strip of land two hundred feet wide along the Potomac river which is a government reservation and not State or County property. It is, however, open for the public use.

Of late years the United States Office of Public Roads has been conducting experiments with roadbuilding and materials and in a desire to secure the conditions of a heavy traveled country road close at hand, have entered into several agreements with the County for the construction and maintenance of certain roads leading into Washington. In all, they now have under their charge about ten miles of road which are now being paved with materials of all kinds varying from brick to water-bound macadam. An accurate record of cost of construction, maintenance, and especially of the life of each class of material will be kept on all these, as their agreement is to maintain for ten years the roads thus constructed. All of these roads are subjected to extremely heavy automobile and hauling traffic and undoubtedly will form valuable object lessons to students of roads. Such experimental work will evidently be the means of determining the road material of the future. This County has been fortunate in having been selected for such work and will thus secure the construction of about ten miles of excellent roads at a total outlay not exceeding \$20,000.

A third method of Governmental work is about to be tried here this year. The Postmaster General has the distribution of a sum of money appropriated for Postroads. This State's share is \$10,000., to be applied to a Post Road in a County which will agree to contribute \$20,000. more. So far no other County has complied with this, while this County has offered to do so. It seems probable that this amount will therefore soon be available; which work will be done in conjunction with the United States Office of Roads.

This completes a brief sketch of the methods employed in Montgomery County in securing better roads and while the total mileage constructed each year is not more than an average of twenty miles which is a comparatively small percentage of the total nineteen hundred miles in the County, yet this average is constantly on the increase. When it is noted that ten years ago the average mileage of this kind of road per year was not more than one, the percentage of increase is encouraging even though the totals are not.

Kinds of Construction.

Before taking up the subject of the kinds of road a few general principles regulating this selection will be reviewed. The traffic over a road both class and amount is of course, next ^{to} ~~the~~ financing the prime consideration in determining whether the road in question ought to be good or bad. If the traffic is sufficiently large, either in number or tonnage the users will eventually demand improvement of some sort. As a community increases in agricultural or other wealth the traffic over its roads invariably increases. If this increase is in tonnage the users of the road soon see their need ^{of a road} whose surface is little affected by the seasons or the weather. If on the other hand the traffic consists largely of numerous

light vehicles the demand is the same. In the first case the incentives are those of pleasure.

The advent of the automobile has greatly increased the latter class of travelers and the sensitiveness of this machine to grades and weather conditions has probably given greater impetus to the good roads movement than any other single cause. In fact so active have the automobile owners been in these matters that in many places farmers have opposed the movement on the ground that the automobilist was the one who derived the greatest benefit, not realizing at first the large proportion of benefit reaped by themselves. Farmers being proverbially conservative where large expenditures are concerned, did not realize the twofold benefit which they received in their increased ease of communication and at the same time the automatic rise in the value of real estate lying adjacent to improved highways. This attitude has however invariably changed with the continual construction of improved roads in any community.

In selecting a road which will fulfil the conditions mentioned, earth roads are at once eliminated, owing to their sensitiveness, in this climate, to the action of frost and moisture. Some hard form of metaling must be adopted whether it be stone, gravel, shell, brick, or concrete. The location and amount of traffic will determine the width of the metaling and its depth.

It is universally observed that a road will always, ^{be subject} and sometimes in a very short period of time to an increase of traffic after its improvement. This should always be borne in mind in the determination of its proportions. Probably no road in even outlying country districts should have less than ten feet of metaling width nor less than a depth of six inches after completion.

From this minimum variations may be made to the width of city streets, say thirty to fifty feet and a depth of twelve inches. This depth is rarely considered necessary, since the introduction of the modern macadam road, except in the case of telford construction. When an eight inch or a ten inch depth of stone or gravel becomes too light some more rigid form of base such as concrete is usually adopted. A macadam road where the traffic is heavy enough to justify a double track will rarely outside of towns require a width of more than eighteen feet or a depth of more than eight inches after rolling. This depth is, however, varied to suit the foundation and in marshy places, even on outlying roads ten or sometimes twelve inches may be required for short stretches.

The automobile has also had another effect on road construction which is, the destruction of a road by removal as dust of its fine particles. The steel treaded vehicles grind the surface to a powder while the swiftly moving motor vehicles with rubber tires remove this from the surface, exposing the stone more rapidly than otherwise and also disturbing the remaining surface by the tractive effort of a wheel designed to grip the surface instead of merely to roll over it as in the case of animal-drawn vehicles. This effect has rapidly turned the attention of roadbuilders to some mechanical means of binding the stone together. For this means numerous bituminous or asphaltic binders have been used. Certain deliquescent substances whose value lay in there ability to retain moisture and this prevent the formation of dust, have also been used. Another, altho minor cause that has given the dust preventive agents an impetus, is the objectionable and unhealthful results of dusty roads. Concrete and brick have lately been advanced as a solution to this problem, they having also additional advantage of long life and reduced cost of maintenance. No fixed rules can be said to have been established

for the selection of any one of these methods, the subject being yet so largely in an experimental stage that all methods have many advocates. There are now in use and in construction in this County several varieties of bituminously bound roads, one concrete road, ^{and} a short stretch of brick road. It can only be said that present indications are that the future road will be a dustless one of some kind.

The subject of grades on an improved road is also largely regulated by traffic but engineers differ widely as to what maximum should be adopted. The subject of ruling grades on a highway is much the same as on a railroad with the exception of course that on the former they are always much higher. This County rarely allows a grade on a macadam road to exceed eight per cent. When it does exceed that amount it is only on a minor road and in the case where the cost of lowering it would practically prohibit construction. It is considered difficult for a horse to keep a footing on a grade in excess of eight per cent in winter. The subject of the economical grade line on lower grades is more one of appearance than efficiency. The practice here is to avoid sharp irregularities in a road except when by so doing, it may be necessary to needlessly disturb existing good foundation.

Earth Roads.

In proceeding more to the details of kinds of roads, earth roads will be treated first. As it has been noted that earth roads in this climate cannot be considered ^{permanent} we may say that the construction of earth roads ceases with the clearing and grading of them. After that the problems become those of maintenance. In opening a new road the usual width proscribed here is thirty feet between fence lines. There are some roads now existing in this county whose surveys

call for sixty and sixty-six feet but these are very old roads. This is unnecessarily wide as in no cases are they ever graded or a traveled way maintained at such a width. Consequently a large amount of land is left on the sides of these roads which is waste so far as agricultural purposes are concerned and in addition this width entails upon adjoining property holders much labor to keep their fence lines clear. A road of thirty feet width is wide enough to accommodate the average graded roadway of twenty-four feet in all cases except where a cut or fill exceeding three feet is necessary. In such cases property owners usually make no objection to the necessary increases of width to take the slope. The clearing of a roadway of thirty feet width thru timbered country and removing stumps usually costs from \$800. to \$2000. per mile. In many cases on opening a new road the full width has not been cleared and stumps are often simply cut off close to the ground and allowed to remain, a practice which is to be deplored and whose only excuse is to save funds on a road which at the time of opening is unimportant. Except in rare cases very little grading has been done on earth roads until immediately preceding macadamizing.

Common Stone Roads.

There are in this County a considerable number of stone roads which could hardly be termed macadam, which have been stoned at various times, either by adjacent owners or by toll companies formed for the purpose. The method followed in both cases has been to cover the road without much preliminary grading or leveling, with a large quantity of large sized stone, usually flint. The tops of these were then broken to form a tolerably smooth surface and usually some earth from the

the sides then thrown over it all. No rolling was done but the traffic was allowed to compact the stone. The resulting road was of course very rough and uneven but had the one advantage of holding travel upon it out of the mud. Practically no attention was given to the condition or shape of the roadbed before placing the stone and drainage was not much considered but the depth of stone was simply increased to meet any unusual condition of roadbed. Much of the work on such roads was given free of charge by property owners. Consequently unfavorable comparison of the cost of these roads with modern macadam has been the result. In making such comparison rarely has the free work been considered nor has the fact, that the cost of labor and team has been increased about seventy-five per cent in the last twenty-five years, been taken into account. With none of these allowances it is common to have the cost of such roads put at \$3000 per mile which is evidently misleading. A comparison is then made between this cost and that of a smooth macadam road.

Undoubtedly toll roads have had a mission but they are at present growing into disfavor in this County. This is due partly to their rough class of construction as compared with the newer macadam roads and partly to the preference of the traveling public to pay taxes rather than toll for the upkeep. Altho the receipts of toll companies have been sufficient to justify the payment of dividends on their capital, it seems evident that the average receipt from a toll road in country districts would never be sufficient at prevailing rates to maintain a road of the type now demanded and also pay dividends. Consequently to meet the demands for abolishment, the County has bought several toll roads at a price usually under the first

cost.

The State Roads Commission is also acquiring various toll roads thruout the State whenever they form a part of contemplated State Roads. These roads have in some cases been reconstructed, the method followed being as follows: If the stone in the top course were not too large to prevent, the surface was loosened by spiking with a roller or scarifying with a scarifier. Where old water breaks or other causes had formed sharp breaks in grade, they were removed. Necessary drainage such as culverts and bridges were constructed. The loosened surface was then crowned with rakes or shovels, rolled and a top course of two inch stone spread and rolled in place. The depth of this course varied from two to six inches depending on the remaining depth of old stone. This was then covered with screenings under $\frac{3}{4}$ inch and rolled in the usual way for macadam roads. Of course if all of the original pike had been removed in the process of grading a first course of two to three inch stone was supplied. The surfacing of roads of this character for a width not more than fourteen feet can usually be accomplished for from \$3000. to \$5000. per mile.

In some instances, as on one ^{on} which the writer was employed, a first course of large stone was used to crown up the old road. The top of this was then broken by hand to three inches and the surface course applied. The large stone was obtained locally from piles and boulders and the average cost \$1.75 per cubic yard in place. The objection to applying stone without first loosening the old pike is that unless considerable depth, say six inches, is used a bond is not secured. It, also, usually takes so much more stone to shape up a road in this way that the expense of scarifying is more than equalled.

Another obstacle encountered, is the building of shoulders to secure width of roadway. This is usually large as all material used must be borrow excavation and the quantity is sometimes excessive owing to the narrow roadbed of old roads. A portion of the State Road on which the writer was employed which was built in this way by leveling up an old pike with crushed flint. The run of crusher above $\frac{3}{4}$ inch was used. The width was fourteen feet which was placed on an old pike barely sixteen feet wide including shoulders. It was necessary in order to conform to the specified width to construct shoulders on ^{one} side of the road an average of four feet wide at top and from two to five high for about a mile. Practically all material for shoulders was borrow. This road cost about \$8000. per mile which cost would probably not have been exceeded if the old road had been plowed and graded to the required width and altho the foundation may not have been quite so good it would probably have been ample with the use of the same quantity of stone.

Macadam Roads.

Modern macadam roads may be divided into two classes, water-bound, and those in which some bituminous, asphaltic or other foreign binder is employed to hold the stone in place. The former have up until the present comprised a large proportion of all roads built in this State and County. Methods vary somewhat but in general may be outlined as follows:

The subject of grading is usually the first considered, as practically all classes of roads require some grading before permanent improvement. As has been stated the practice in this vicinity is not to allow grades on such a road to exceed eight percent except where unavoidable. Considerable difference of opinion exists as to the desirability of reducing lower grades where the object is one of appearances only. The

location of a road where close to a city or not will largely govern the determination of this. Considerable adverse criticism has been made of the State Aid Roads on this point. Other than eliminating sharp breaks and extremely short stretches of grades higher than those adjoining, the writer considers the reduction of grades lower than eight percent unnecessary, say on country roads.

Some consider that a minimum of one per cent should be held for purpose of drainage. This, however, appears unnecessary as gutter grades need not conform absolutely to the centre line and as all macadam roads are crowned from side to centre a longitudinal minimum seems a superfluous refinement where the gutters can be so lowered as to supply the required fall.

In certain very marshy places drains of tile or broken stone under the macadam may be necessary but the writer has never personally encountered on construction work, places where this was unavoidable.

After the grading is completed and rolled and all culverts and under drains placed what is known as the subgrade is prepared. This consists of a trench of the width and depth and shape of the finished road. It may be cut by hand or with the plow and road machine, as the writer has found cheaper and more convenient. In the latter method two or three furrows are run along the outer edge of the subgrade. This is then ~~pushed~~ pushed outward by a road machine. The depth is made sufficient for the first course and then the material pushed out will be sufficient for the shoulders of the second course. Some hand work will be necessary to properly line and smooth this grade. The formation of holes in it should be avoided as they form a place for collecting water in addition to requiring stone to fill them. In hollows it may be necessary to furnish subgrade drainage by cutting small, transverse ditches

from the bottom thru the shoulder to the gutter. These are filled with broken stone and are of great value in preventing softening of the bed before the stone has been thoroughly rolled. These also are of some value after the road is finished. For at least twelve hours after a hard rain water will drain thru these blind ditches from under the stone.

The first course consists of stone over two inches and under four called No. 1's. This is either spread directly from specially constructed wagons or dumped in the subgrade and spread by shovels or special stone rakes. Blocks are usually used to indicate the thickness. These are taken out after spreading. Some specifications require stone dumped upon boards and spread from them by shovels, the object being to avoid the hard spots formed under a load dumped directly on the subgrade. The writer considers this unnecessary if care is taken in use of the other methods. The first course is rolled until no creeping is observed. The second course of stone over $\frac{3}{4}$ inch and under two inches, called No. 2's, is then spread similarly to the first. This is rolled until the ^{stone} is firmly keyed. The dust under $\frac{3}{4}$ inch is then spread preferably from piles on the side or from a cart. The surface is covered with dust which is then rolled slightly and sprinkled thoroughly after which it is rolled thoroughly. As stone appear during rolling they should be covered with more dust and rolling continued from side to centre until a thorough bond is secured.

The time required for this will vary considerably with the character of stone used. Soft limestone will cement quickest while trap will require most rolling. Rolling is always begun on ^{the} shoulders and continued from each side to the centre, ^{the} rollers always being on one side or the other of the crown. This varies from $\frac{1}{2}$ inch to one inch to the foot in

different specifications.

In some cases, as in flint, it may be necessary to spread a layer of clay over the first and second courses in order to secure a bond. This is, however, always thin, say not more than $\frac{1}{2}$ inch to $\frac{3}{4}$ inch. The writer was employed on one road built entirely of flint, in this way, clay being used over each course, the last application was rolled several times and then covered with a flint dust to a depth sufficient to keep the clay from sticking to the roller wheels after being sprinkled. While this road did not present quite as smooth a surface on completion as roads built entirely of stone of other kind, the surface was very satisfactory.

Local stone has been considerably used in this vicinity, several different kinds being available. The use of local stone, however, requires an outlay for crushing machinery and for a short stretch of road this is usually considerable. In addition to this it is often found expensive to quarry, collect and crush stone unless a ledge suitable for a quarry is available. Consequently it is often found cheaper to buy foreign ^{stone} where the haul from the railroad is not too long.

In the eastern section of this State where no stone appears locally and freight rates on stone are prohibitive shells are often used in much the same manner as stone. Roads of this character are subject to wear at much greater rate than stone and in addition are extremely dusty in dry weather. Gravel has also been used with good results for construction of roads where it is easily procured.

The item of sprinkling water-bound roads is usually a considerable one and especially so in the cases where a very hard rock requiring much rolling is used. The sprinkling is usually accomplished by special sprinkling wagons, and requires

from four to eight horses constantly at work. On one piece of road where the speed was about $\frac{3}{4}$ miles amonth and the stone was hard boulder trap four rollers required two four-horse water wagons almost constantly during June and July. Water was supplied to a tank by a gasoline pump and drawn from there into the wagons. It will be seen therefore, that furnishing the necessary amount of water for water-bound macadam often amounts to quite an item and often furnishes an additional argument for use of some mechanical binder.

Bituminously bound macadam, including also asphalt has the great advantage of being dustless. This under conditions of motor traffic means longer life. Automobiles have done much to popularize thie class of roads. Their construction is usually by one of three methods: mixing, penetration, or simply a carpet on a water-bound road. The first is the most expensive and probably the most efficient. The latter is simply a dust preventative. The first method consists of mixing the second course stone sometimes hot, and sometimes cold with the binding material hot in a mixer, and spreading this in a layer on the road. This is then rolled, covered with a paint coat and then ^{covered} with crusher screenings from which the dust has been extracted, and the whole rolled until solid.

The penetration ^{method} consists in applying the hot binder to the second course which is then covered as above and rolled. In either case the amount of rolling is greatly diminished over water binding. These methods usually cost from ten per cent to twenty-five per cent more than water-bound macadam. The tar carpet is simply applied to water-bound macadam whose surface has been previously swept free from dust. A coating of screenings or fine gravel is also applied over this tar. This method has become rather popular on account of its low

first cost which is from \$600. to \$1000. per mile. One application is effective for from two to four years. The usual amount specified is $\frac{1}{2}$ to one gallon per square yard.

Bridges and Culverts.

The construction of culverts and bridges is a subject which occupies much of a road engineer's attention. Small culverts may be either of wood, tile, corrugated iron, cast iron or concrete. This County has now practically abandoned the construction of all wooden and tile culverts on account of their short life.

Next in point of cost comes corrugated iron which has cheapness and lightness to recommend it. Its life is at present undetermined as it has been on the market but a few years. However, it seems evident that it is superior to either wood or tile.

Cast iron is generally considered next in durability, but its cost is more and the cost of hauling and placing much greater. All pipe culverts should be provided with headwalls either of concrete or rubble masonry and on all improved roads the County is doing this.

Concrete of course makes ideal material for all culverts either large or small and is coming into use largely here but especially for small arches and bridges of slab or box form. For the larger bridges a number of concrete arches have been used recently altho the great majority of all bridges in the County are of steel with wooden floors. The present practice is to require all steel bridges to be constructed with a concrete floor. The writer has constructed several concrete slab bridges up to fifteen feet span. Above this span either steel or concrete arch is used. Paving is usually continued over bridges thus constructed altho occasionally a

troweled wearing surface has been required.

Maintenance.

Earth Roads.

The subject of maintenance of all classes of roads is one which attracts much attention. As previously noted most problems relating to earth roads are those of maintenance. The road machine and split-log drag are the instruments which lead to good earth roads. To properly develop the use of these machines the writer believes some system of district supervisors is necessary thus establishing what is really a patrol system, which is now so much in vogue in States and foreign countries, having good roads system. The old method of numerous supervisors has resulted in no uniformity of method and consequent lack of results. The split-log drag has not yet been generally introduced but efforts are being made to have the district supervisors now appointed use them and demonstrate their effectiveness. If an earth road is crowned once or twice a year with a road machine and dragged after each rain the ideal condition for that kind of road is obtained. In addition to this the side drains and culverts should be kept free and open. The practice so often followed of scraping sod and leaves to the centre of the road should always be discouraged as such material on decomposition keeps the bed loose and open.

Macadam Roads.

The maintenance of a macadam road varies greatly in cost with the traffic. Holes should be repaired as soon as they appear and it is even more important that side drains and culverts should be kept open on this class of roads than on earth roads. The patrol system best secures these results. One man with a horse and cart should be able to care for from six

to twelve miles of macadam roads until such time as resurfacing is necessary. To some extent patrol system is followed here. The sum of \$150. per mile is allowed here for macadam and stone roads which should be sufficient for ordinary repairs.

The proper care and maintenance of all roads is equally important with the selection and construction of improved roads, as the road has not yet been invented which once built, will maintain itself. If this problem is neglected it is invariably seen that in a short while results of the original expenditures will have entirely disappeared and the roads will practically require reconstruction. In this matter engineers and officials would do well to profit by the experience of foreign countries where the subject of road construction is not a new one. As the majority of all roads in these countries are improved, attention has been directed more to subjects of maintenance for some years and highly improved methods and organizations for this important branch of the work have resulted. Consequently it may be said that the sooner our attention as a people is directed to problems of maintenance, the sooner our improved system of highways will become a permanent institution.

Statement of Professional Work.

June 1908 - June 1913

September 1908 to August 1909.

Employed by the Maryland State Roads Commission as
rodman.

Work: Preliminary and final surveys of about one
hundred and fifty miles of roads. Also some
office work in connection with the plans for
the same.

May 1910 to September 1910.

Employed intermittently by the Commissioners of
Montgomery County as engineer and foreman.

Work: The construction of several small bridges.

September 1910 to April 1912.

Employed as foreman on road construction by the Com-
missioners of Montgomery County.

Work: General charge of concrete work and later of
macadam construction on portions of the State Road
built by the County. Assisted on approximately
eight miles.

April 1912 to June 1913.

Employed as Superintendent of Construction on road
work by the Commissioners of Montgomery County.

Work: April 1912 to October 1912. In charge of all
the County's forces and machinery on the construction
of a section of three miles of the State Road under
the direction of the County Road Superintendent.

October 1912 to June 1913. In charge for the
County, under the Road Superintendent, of various road
and bridge work. Also preparation of designs and

estimates for road and bridge work.

Respectfully,

Edward H. Deets.

To The Faculty of the School of Applied Science
Washington and Lee University,
Lexington, virginia.