

The report should be constructed so as to show variations between the estimated and actual cost. In cases of significant variations, the executive must receive explanations of the causes. Details are of value only for the purpose of explaining variations.

The report must show the financial condition of the department in summary form, supported by details of items comprising the various assets and liabilities.

Revenues should show sources and amounts. Expenditures should be shown by funds and purposes.

Statistical information should include the classes, types, and qualities of work performed. Cost accounting reports should include current costs, cost of past periods, and estimated costs, by classes and types.

The internal budget, a most important guide for the administrator, is necessary for the proper allocation of funds, and its observance and control is essential.

The highway administrator, be he state or county, owes to himself and to the people he is serving the most efficient and economical administration of highway funds within his power; and the best weapon available for defense against unfounded charges of partisan critics is obtained through adequate fiscal, statistical, and cost accounting reports.

THE COMMISSION'S RESPONSIBILITY TO TAXPAYERS

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Many general policies, rules, and regulations are necessary for administering the affairs of so large an organization as the Indiana State Highway Commission. The tendency in all governmental bureaus, be they local, state, or national, is to try to provide ready-made solutions for the problems to be met. This results in an ever-increasing number of standards, regulations, and restrictions tending to make procedure more and more mechanical, to the end that rule and red tape, rather than merit, too often govern.

The very human desire for power and authority leads bureau heads to entrench themselves behind the wire entanglements of red tape and regulations which have official or semi-official status, to the extent that the creating power of such bureaus loses control of policies and methods of procedure. The bureau, therefore, grows into an autocratic dictatorship, frequently exercising far greater powers than any elected representative of the people would dare to assume.

Governmental bureaus are supposed to be outside of politics, that is, partisan politics; yet many of them are very successful in practical politics in that they hold on to the

but will resent it very much if their requests are given scant courtesy and consideration.

ROAD LOCATIONS

The State Highway Act is quite specific as to the duties of the state highway commission in laying out "a system of highways which shall reach each and every county seat of the state and each and every city or town of over 5,000 inhabitants," and in providing also for the connection of these trunk highways with the trunk highways of other states.

We infer from the above that the legislature had in mind that the state highways would be built primarily for the benefit of Indiana farms, towns, and cities, and would contribute to their prosperity and welfare. We might further infer that these highways should enter and pass through these cities and towns along convenient and satisfactory streets and not merely touch the city limits at some out-of-the-way corner. A further liberal interpretation would apply to towns smaller than 5,000, where the general route makes it practicable to pass through such towns. It certainly kills the small town and depreciates the investments of its citizens to be left off a state road that could conveniently pass through it.

Since I have been a member of the commission we have made many inspections where locations were unsatisfactory to the local community, and while we have sustained our engineer in the recommended location in most cases, I may say that I have not always been impressed by the reasons for their adoption and have felt that our time was not profitably spent. The principle of paternalism too often finds its way into these recommendations and the commission, without the means or time to go into great detail, finds itself reluctantly approving something not wholly satisfactory to it, probably unsatisfactory to the majority in the community affected, but eminently satisfactory to our experts who prescribe just what, in their opinion, is best for the community.

Absurd departures from the general line of a road should not be made in order to please a community; but where practicable, if our route will save the county the expense of constructing a road, or may be of like service to a town, we should give the matter our consideration, as these improvements must all be paid for out of public funds, be it town, county, or state.

A little inconvenience to the through motorist can be justified if the local community is better served. The primary reason for building state roads is to serve local communities. State and federal highway engineers almost unanimously advocate by-passing cities and towns, thus favoring the through motorist at the expense of local convenience. On the other hand, residents, especially of the smaller communities, almost universally desire that highways pass through the business sections of such towns.

It is evident that locating the road through the town does benefit the town for the reason that most towns immediately pave to the full width of the street over which a state highway passes and install boulevard lights and other improvements. Along with these improvements, the business men usually improve their store fronts and properties. When the town is by-passed, a collection of gas stations, hot dog stands, and tourist camps spring up near the town and property values in the town itself are depreciated.

It might be argued that, because most highway engineers advocate by-passing towns, this theory be adopted as a standard and imposed on communities regardless of the desires of its citizens. It might also be argued that inasmuch as most of the citizens want the road routed along the main street, they, being taxpayers and right on the ground, should be considered favorably, regardless of other objections.

I do not believe any hard and fast rule should be adopted. We hear a great deal about some of these locations being engineering problems. This is true in special cases, but in others utility as to the community served should be considered first and the engineering worked out on this basis. In other words, the road should not be regarded as a unit separate from the communities it passes through, its grade, alignment, and location being governed solely by the engineering features encountered. This would be ideal for an undeveloped country; but where everything is established, the engineer must use his talents best to meet existing conditions and serve the greatest number of people in them.

On roads of national or interstate character considerable attention must be paid to affording a free passage through towns. On those of more local character, local requirements should predominate. In every case, however, the town should be required to provide a street of sufficient width to take care of the situation. If no such street is available, then the highway must of necessity by-pass the town.

The engineer of twenty years ago, or of even a dozen years ago, did not foresee the requirements of today. We may not see the requirements of a dozen or twenty years in the future. It may be that in the near future towns will want all main roads by-passed around them, with an alternate route marked through for those who desire to stop. If so, this will leave a little work for the next generation. In my experience of more than thirty years as an engineer I have noted that few things can be planned and followed for the next generation. I have also noted that few roads last for a generation. It would, therefore, be the prudent thing to work toward meeting present conditions satisfactorily, rather than to try to guess what might be required in the future.

ROAD DESIGN—TYPES AND CLASSIFICATIONS

Road design includes location, which has been discussed. Curves, both horizontal and vertical, and gradients are engineering features which do require standards. These standards have been most carefully worked out by our engineering department and are most satisfactory for present-day conditions. It is commendable that our engineers insist on following these standards in all cases, except where some unusual condition makes their application impossible. These standard curves and grades can be negotiated by modern high-speed automobiles without danger, while some of those considered satisfactory a dozen years ago are now dangerous.

The type of road surface is a matter not only of engineering, but also of good judgment. Roads naturally fall into classification as primary, secondary, and lower grades, according to their location and the population served.

Thirty or more years ago, sheet asphalt was considered one of the most desirable types of surfacing. Afterwards for many years vitrified brick was the most popular. Then came the development of concrete paving. This road can be built more cheaply and does give a most excellent surface for automobile driving. All these types have been promoted by national organizations, and many improvements in construction are due to the insistence of these associations that their members produce high-class work.

The National Brick Manufacturers' Association for many years carried on extensive experiments tending to develop the best methods in building the best brick pavement, and many examples of their high-class work of this kind exist today, much of which requires little maintenance.

In the same manner the Portland Cement Association has developed and improved cement construction to the end that we have excellent concrete roads and other structures everywhere.

These are what might be termed high type roads. There are many state roads in Indiana that will not warrant an expenditure of \$25,000 to \$30,000 per mile. The mileage of these lower-class roads is, or should be, many times greater than that of the high-class roads. Our mission is to serve the greatest possible number with a serviceable, dustless road. We have many thousands of miles of stone and gravel roads which can be surfaced and saved. It is the duty of the commission to conserve these old roads where possible. To do this we must have the whole-hearted co-operation and support of both our own and the federal bureau engineers. The people of each community must themselves get away from the idea that the state and federal grab-bag has no bottom and that funds from these sources are unlimited. They must consider it as they would their own money and not demand a super-highway where a country lane will serve. They must

be satisfied with some existing sub-standard improvements until a higher class can be justified.

Indiana is said to have approximately 73,000 miles of road, of which about 7,000 miles are state roads, 41,000 county roads, and 25,000 miles township roads. Of this mileage 69 per cent is improved with some character of surfacing. This percentage is far above that of any other state in the Union, and even far above the next state, Ohio, which has 52 per cent, the average for the nation is 23 per cent. Most of the county and township mileage is gravel or stone macadam, although there is a considerable mileage of high-type pavement. These roads have cost counties and townships more than \$350,000,000 since January, 1920. Most of the bonds on these roads are still running and will be for many years.

The types usually constructed by the Indiana State Highway Commission are: Cement concrete pavement, rock asphalt surface pavement, bituminous retread surface, bituminous mulch surface, and oil mat surface.

The first two are high-type pavements, and cement concrete is probably the most popular for new construction. Rock asphalt makes an excellent and desirable riding surface, but requires a substantial base and will cost as much or more than cement concrete where entirely new construction is being considered. This material can be used to advantage in resurfacing old road surfaces in many cases.

Bituminous retread is a resurfacing process consisting of a layer of stone, slag, or gravel, of sizes $1\frac{1}{2}$ to $2\frac{1}{2}$ inches, laid to a thickness of $2\frac{1}{2}$ to 4 inches over the old road bed, macadam, or gravel. Bituminous material, consisting of tar, cut back or emulsified asphalt, is applied, and the material thoroughly mixed by harrows, graders, and planers, and compacted by rolling; it is then finished by successive applications of bituminous material and fine aggregate in the same way as penetration macadam is constructed. This type has a smooth riding surface and will carry heavy trucks satisfactorily. The annual report for 1930 showed 137 miles of this kind of surface in the system, some of which carries the heaviest traffic.

Bituminous mulch surface consists of a layer or mat of stone, slag, or gravel, ranging from sand particles up to $1\frac{1}{2}$ -inch stone, mixed in place with some of the bituminous materials suitable for this work and applied on a prepared old macadam or gravel road bed by alternate applications of bituminous material and aggregate, and worked down to a smooth surface by scraping and dragging. The bituminous mulch surface will carry quite heavy trucking and is ample for all ordinary automobile traffic. Successive maintenance applications not only keep this type of surface up to standard, but actually improve it as time goes on.

The *oil mat surface* is a cheaper type than the bituminous mulch surface but is constructed in a similar manner, using

a cheaper grade of oil incorporated with finely graded crushed stone, slag, or gravel, intimately mixed by means of graders and drags. Usually the mat is one to two inches in depth. This type of surface is not satisfactory for a large amount of heavy trucking, but for ordinary touring traffic and light trucks, it will carry almost an unlimited amount, except during spring thaws when it may be damaged considerably. These pavements are easily reconditioned after such thaws and can be scarified, and with the addition of some new materials will gradually become stronger from year to year.

Retread and oil mat roads require surface treatments from time to time, but each successive treatment adds to the thickness of the road and the weak portions are gradually brought up to standard.

The bituminous retread surface can be built on the prepared existing foundation for \$5,000 to \$7,000 per mile. The bituminous mulch surface costs from \$2,000 to \$3,000 per mile, while the oil mat surface can be produced as low as \$1,500 per mile.

It may be repeated here that the old road bed must be in good condition and sufficient to carry required loads if any of these three types of surface is to be successful.

Rock asphalt surface is one of the high types of bituminous surface. It can be constructed with a smooth, easy-riding surface, and because of cost it must be constructed on a substantial base. It makes a high type resurfacing job on old concrete or brick pavement, and can often be used to advantage in resurfacing macadam pavements where excessive materials are not required for leveling up the old base. This improvement costs from \$11,000 to \$13,000 per mile. This cost will be increased on old macadam pavements, where considerable material is needed to produce a proper grade.

Other forms of bituminous hot and cold mix are employed in resurfacing with good results. A good foundation is essential to these types, and where properly built they may be classed as first-class roads. Such roads are perhaps the most economical, as they will last forever with proper maintenance, while a rigid pavement will eventually so deteriorate that it must be replaced or resurfaced. Where no such base is available and the road must be built from the ground up, most of these types will cost about as much as a cement concrete pavement.

Cement concrete pavement is perhaps the most popular for heavy traffic, primary roads. It gives a smooth riding surface, lasts for 15 to 20 years before maintenance becomes excessive, and can be resurfaced at that time with a bituminous surface and made to last almost indefinitely. A concrete road complete with small structures and grading costs \$25,000 to \$30,000 per mile.

SAFETY PROVISIONS

The growing death rate on public highways concerns highway officials very much. Automobile speeds have increased, and on the new roads curves are now built that can be safely negotiated at 60 miles per hour. Vertical curves have been flattened so that vision can be had of cars at a safe distance at summits.

Stone berms are now constructed at the edge of the concrete slab so that cars that run off the edge can get back on without danger of being wrecked. Grade separations are constructed at intersections of principal highways and railroads, and even at a few of the most important intersections of highways. "Danger," "stop," "warning," and "information" signs are placed along roads where needed. These signs are pretty well standardized through national co-operation; and eventually the size, shape, and color of sign will be of the same significance throughout the whole country, and good drivers will almost automatically observe them. Advertising signs of all kinds have been entirely eliminated from rights-of-way. The elimination of cars with faulty brakes and lights, and the compelling of all to have similar lights with dimmers contribute to safety. With all these precautions roads cannot be made fool-proof, nor can all reckless drivers be eliminated; so we will no doubt continue to have many fatalities under the most carefully worked out system.

Most deaths and bad accidents occur on straight stretches of road; many occur at railroad crossings where vision is perfect for hundreds of yards in every direction. We must, therefore, make our roads safe for those who travel with due caution and prudence and do the best we can for those who do not.

MATERIALS COMPETITION

Coming back to public and business relations, it may be stated that the state highway commission is the biggest business corporation under the state government. The commission dispenses about \$25,000,000 per year; consequently, its business is eagerly sought by material men and contractors. During the existing depression the keenest competition and rivalry exists, and all these interests put forth every effort to get a good share of the business. These material men and contractors are an essential part of the highway business and our relations with them should be frank and cordial. Most of these men are high type men and ask consideration only on merit. Some have not been so ethical. During the last session of the legislature some of these interests endeavored to promote legislation that would abolish the highway commission and in other ways tried to embarrass that body. Since that time these interests have continued in their endeavors to discredit certain phases of highway work—much

vicious propaganda found its way to the public press, none of which will profit those responsible, but will work some injury to road building in general.

This propaganda was aimed largely at what is designated as "black top" construction, whatever that means. (Parenthetically, the writer may state he never heard the term used until he became a member of the commission.) It is probably intended to classify all bituminous surface roads under one heading. This classification is erroneous, as the several bituminous types referred to and described herein are so different in composition, construction, and cost that they cannot be classified together. The similarity in color is perhaps the principal excuse for classifying them together. The Dunes Highway is a concrete road, but the extremely heavy traffic has made it a black top road because of the oil dripping from the thousands of cars that travel over it daily.

A permanent injunction has been obtained which will practically prevent any resurfacing of existing roads with any of the higher types of bituminous construction. Therefore, when a concrete or brick road reaches the point at which it cannot be efficiently maintained, it must be broken up and a new slab constructed. Likewise, when it would be practicable to make a first class improvement on a good macadam base, the old macadam must be scraped off into the ditch and a new road constructed.

A joker found its way into the legislative acts of 1931, which provided that plans and specifications for all improvements costing more than \$10,000 per mile, where federal aid was had, should be prepared by the chief engineer, and that on similar projects where federal aid was not asked, the plans and specifications should be equal to those on which federal aid was obtained. Incidentally, there would be no means of determining what federal requirements would be on a road where federal aid was not requested. This law has the effect of preventing most of our resurfacing jobs, because the federal bureau engineers are loathe to approve the projects except by imposing such conditions that the cost is excessive and almost, if not equal, to building a new concrete pavement. Some of the state engineers seem to be in harmony with the bureau, whose theory is fine from the single track idea of only building the highest type of road, but is not so practical from the viewpoint of the taxpayer who foots the bills. This law will cost the people of Indiana untold millions of dollars if allowed to stand. The extravagant conditions of 1925-29 will not return in a generation, but we will still be paying for them. We must have in all lines a period of economy, conservation, saving, and retrenchment. Our highway program can be no exception.

Our concrete, bituminous, and macadam roads are all similar in one respect; that is, the great mass of material or aggregates entering into their construction is the same—crushed

stone, slag, or gravel. A comparatively small amount of portland cement is required to cement the stone in cement concrete. Likewise, a comparatively small amount of the various bituminous compounds, such as natural or manufactured asphalt and tars, all of various consistencies, are required for the various bituminous pavements, while for the water-bound macadam, stone screenings and water form a low quality cementing agency.

Some references have been made to bureaucratic methods and also to stands taken by federal and state engineers on some of the cheaper types of improvement and resurfacing. It is natural that an engineer should want to build that which might be considered the latest and most up-to-date type of improvement, regardless of the economic aspects. He does not have to find the money for the work and does not have to show dividends, or make an accounting, hence if he builds the road from the ground up, in the most approved and up-to-date style, destroying or discarding whatever may remain of the old roadbed, he will have a fine structure when completed.

In trying to build up his own reputation for installing only the most expensive and perfect types, he may and does lose sight of the main object of road building—to serve well the greatest number, rather than give super-service to a few.

CONCLUSIONS

Our highway commission, fully to perform its duties, must not grow into the arbitrary practices of most state and federal agencies, entrenched behind a maze of rules, regulations, orders, and ordinances. Consideration is due communities. We have no moral right to depreciate values by locations for engineering expedience only, or to change grades in towns for the same reason. The convenience of citizens of such communities should at least be coordinate with that of the through tourist.

In the matter of policies as to construction, it must be borne in mind that certain roads are primary in their nature and will carry heavy traffic. These should be built of concrete, or other high-class construction. Other roads of secondary nature should be retread or bituminous mulch, while others of a lower classification should be the lower class oil mat.

The public should know that if we build all of our roads of concrete or other expensive construction, in seven or eight years we will be through. These roads are not permanent, their life is 15 or 20 years at most; hence in a few years their replacement and maintenance will equal our entire budget and we could never build another mile of new construction, and some who now expect state built roads will never get them.

Since 1920 counties and townships have expended more than \$350,000,000 for roads. The people will be paying off

these bonds for years to come, wearing half soles on the seats of their trousers and on their shoes, and having the old bus repaired once more to conserve funds for township, county, state, and federal taxes and gasoline taxes.

Practically none of these county and township roads conform fully to the very exacting federal requirements. Grades, alignments, and other details are unsatisfactory, although most of them are fairly good for all ordinary traffic.

In the prosperous days of 1925-26-27 and 28 we became accustomed to lavish expenditures of public money. Federal and state bureaus grew and grew, and their demands were constantly for more and more funds. We hear talk of economizing in public office. Public expenditures must be cut materially, not by thousands, but by many millions. Perhaps we may have to do a lot of half soling on our roads instead of plowing off into the ditches the \$350,000,000 expended by township and county. People are inclined to ask for the best and for everything, when it comes from a state or a national fund.

Many feel that they are cheated if they do not get the most expensive improvement possible. The material propagandists are largely responsible for this condition, in that they go out and solicit and promote improvements that cannot possibly be justified by conditions. Lavish expenditures are thereby demanded, apparently by the community, on roads that can never be of even a good secondary status. We are often told that they want the highest type or nothing. Many of them will get none. People must realize that there is a limit to even state and federal funds and that they must be expended judiciously.

By no means would I advocate inferior construction or lowering of standards of the work we do, but I do believe we must conserve the vast millions that have already been spent and get all we can out of them before plowing them off into the ditch. We can have many thousands of miles of serviceable, dustless roads, serving the greatest number, rather than a few thousand miles serving as monuments to our engineers.

We will, no doubt, be continually attacked by selfish material interests and trade associations. We will be accused of being partial to cement, black top, gravel, crushed stone, slag, etc., from time to time; but this is not important so long as we favor each of these materials in its proper place.

We need some legislation which will permit us to conserve our roads and resurface them without having to ask permission of the federal government. We need some wholesome publicity about our work in place of the vicious propaganda that has been the fashion for the past two years.