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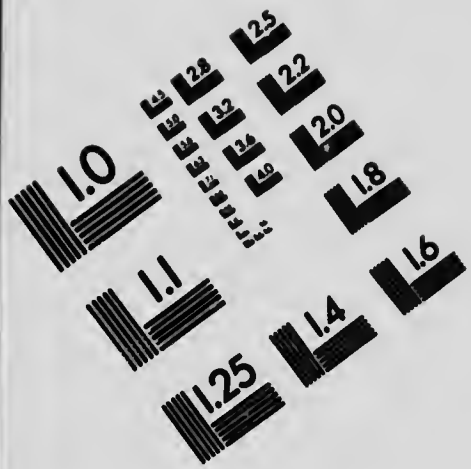



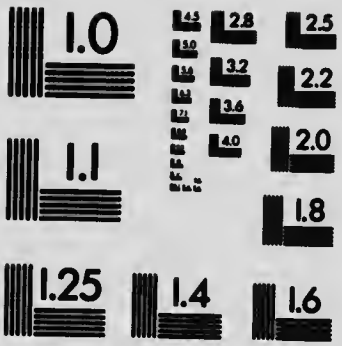


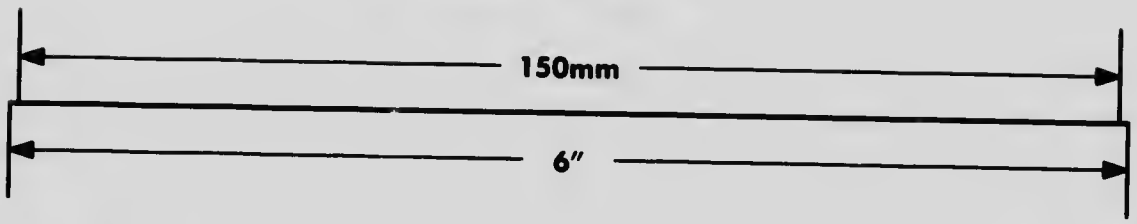



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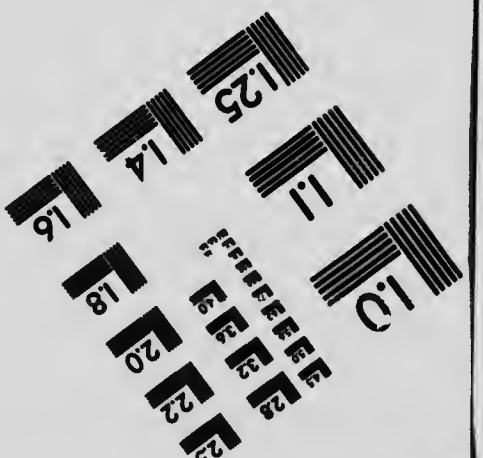

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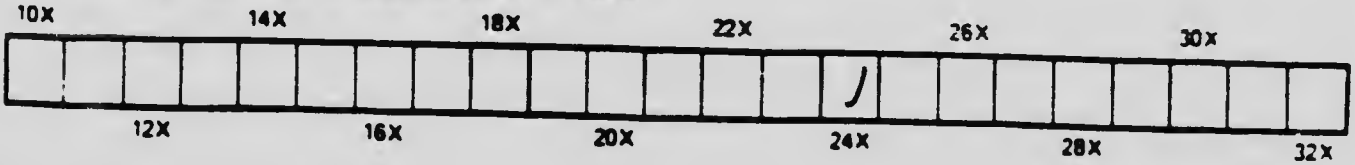
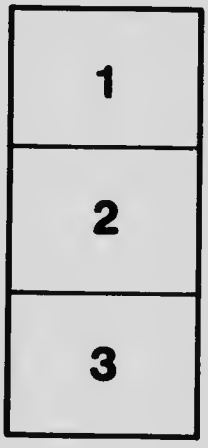
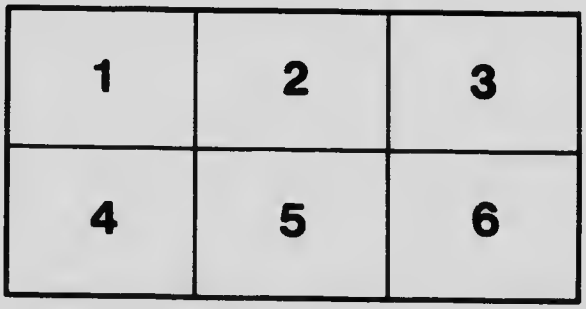


Supplement to the Stratford Beacon

# C. W. A. Good Roads Department.

# TOWN STREETS

—BY—

ARCHIBALD CAMPBELL, C.E.,

Government Roads Commissioner for Ontario.

"As We Would Like to See Them."

Published by the Good Roads Committee of the Canadian Wheelmen's Association.

## For Free Distribution.

Persons willing to make use of these booklets, may obtain a supply by applying to H. B. DONLY, Simcoe, Ont.

# Town Streets and How To Build Them. . . .

By Archibald Campbell, C.E.

Canada is a young country, full of life and energy that is rapidly expanding into a maturer national vigor. Canada possesses a wealth of territory and lake, forest and mine, soil and climate, unsurpassed by any nation on the globe. Cultivation and development are daily adding to these great natural resources. It is a truism frequently stated, that the condition of the country's roads are an index to the degree of refinement which the people have attained. Viewed in this light as well, it is gratifying that Canada possesses some of the greatest highways in existence. There is that great trans-continental route from Halifax on the east, to Vancouver on the west, constructed with a skill and daring that compels the admiration of the world. Populous districts are a net-work of railroads built at great cost, and supplying a rapid and convenient means of transit, in harmony with the highest stage of intellectual development.

But while Canada possesses some of the most magnificent highways that science can devise, there is within its borders a species of highway which, in point of crudeness, is also unsurpassed by any country pretending to a place among the civilized nations. These are not merely the back concession roads, nor necessarily are they country roads alone, but they exist in the populous centres, not merely the villages and towns, but too frequently in the cities. Road improvement is by many regarded as merely a matter affecting country roads. It is the case, however, that the roads of some townships are better than the streets of the towns into which they converge; and it is also very true that many isolated country districts show more activity in the matter of road improvement than do a great many towns. But it is true further that the reverse should be the case.

In towns the amount of street mileage is very much less in proportion to population and financial ability to construct roads, than in the country districts. It is important for the farmer that he should have easy access to the market town by means of good roads; but it is also important to the townspeople that the farmer should be able to get into the market town conveniently and cheaply. The prosperity of the agricultural community means like prosperity for the town, and the towns should, if only for the sake of the example, see that the streets are well built and maintained. Town streets properly constructed would speak more for the cause of good country roads than would all the wordy argument that could be invented.

In our towns it is the ambition of all to have the houses handsomely built, lawns tastefully kept and designed, stores and offices arranged in the most attractive and convenient manner, churches, schools and public halls erected in an imposing and durable style; but it seems as though all were satisfied to see the streets in front of these, shapeless and irregular, at certain seasons of the year, almost impassable bogs.

That town streets throughout Canada are of such rude construction is due in part to the newness of the country. While Quebec, Nova Scotia, and New Brunswick may claim some slight distinction with regard to antiquity, there are few towns of Ontario and the Western Provinces in which there are not still residents who can recall the time when the busiest thoroughfare was merely a rustic highway, perhaps an Indian trail or a blazed line. The town fathers are still, many of them, men who have helped to clear away the forest, or plow the unbroken prairie, on what is now the town site. So gradually have the changes from a primitive wilderness to the abode of civilization taken place, that councillors scarcely yet realize that it is not country roads, but town streets which they are expected to design and maintain.

## Supervision of Public Works.

Residents of cities, having larger and, generally, longer experience in street paving than the average town, are becoming more and more impressed with the necessity for skillful management of this branch of public affairs. This is the result of the

greater importance which is being attached to the care and construction of streets, and also to the opportunities for waste which are found to accompany improper and inexperienced management. Very few towns and cities feel like increasing their rates of taxation; and raising, as they are, large sums of money annually for street purposes, when this is misapplied with the result that streets are in a shockingly bad condition, there is every reason for the taxpayer to feel discouraged. Street improvement in most towns is placed in the hands of a committee of the council. The chairman is a retired farmer who has served his apprenticeship at statute labor—and who knows all about town streets; his main object is to keep down taxes. Another member is a prominent tinsmith, and knows all about streets. Another member has been a grocer all his life, but knows all about streets. Another member of the committee is a lawyer, and knows all about everything, streets included. Another member is an insurance and real estate man; he likewise can give a paving expert advice with regard to designing streets. Still another keeps a livery stable, has driven over the roads more than anyone else, and of course knows better than anyone else, how they should be made. In details or principles, however trifling or important, it is remarkable how such a committee, composed of so many paving experts, are found to unanimously disagree. The chairman is authorized to see that a certain piece of work is performed. He gives the orders according to his ideas, and the workmen appear on the scene. In the course of the day, a member of the council comes along to see that the chairman is making no mistake, finds that the chairman is entirely wrong in his methods, and the work is stopped until a special meeting of the committee can be called together to wrangle over a matter on which none have any reasonable or intelligent opinions. This is not a pleasant picture, but it unfortunately is true, more or less, of the vast majority of public works committees. The improvement they undertake is merely patchwork, ill-contrived, endeavoring to make town streets as though they were back concession roads.

Archibald Campbell, C.E.

The average committee-man thinks there is very little to know about streets, and consequently he knows it all. The reason men so often know all about streets, is because they do not know how much there is to know. It is a subject on which engineers have been experimenting and studying since A. D. 1—and previously—and still there is more for them to know. Volumes have been written on the subject, and still there is more to write. If committees are still to carry on street construction, it is time each councillor should study the experience of those who have given it careful research from a scientific point of view, instead of evolving so much from his inner consciousness. But councils are constantly changing; councillors are each year resigning or being defeated at the polls; many do not hold office for more than a year. Under such circumstances it cannot be expected that a councillor will be in a position to study the question as an expert should.

As the importance, difficulty, and requirements of the matter become better understood, every municipality will have at its command the services of the local engineer to guide it. Most intelligent councillors have already learned the need of such an officer. The people, however, havenot yet quite learned that street improvement requires more scientific skill than the average councillor possesses. After a little more experience with the wastefulness of present methods, councillors will be able to engage the services of such an expert, without the almost certain danger of losing their (official) heads at the hands of an outraged electorate.

## Annual Appropriations.

The majority of towns pay for work on streets by making annual appropriations from the general funds of the municipality.

The amount varies greatly with different towns, according to size, wealth, requirements and liberality in this respect, ranging usually, from one to ten thousand dollars. This money is distributed over the town in several ways. In some cases it is sub-divided among the wards ; the basis of this may be the assessed value of the property in each ward, or it may depend on the skill of the ward representative in wire-pulling. In other cases the ward boundaries are overlooked and the money is divided as the council may deem advisable; in this instance, influence is usually brought to bear directly on the council by individual citizens or bodies of citizens.

In whatever form, the final tendency of this method of making expenditure invariably is to scatter the appropriation over the whole street area, not in accordance with the actual improvements needed, but according to a councillor's idea of equity, modified by his desire to retain or gain the support of his constituents. The manner in which the appropriation is spent makes it a sort of legitimate election fund ; the people expect it and the council has no other course to pursue. The character of the work done is merely temporary patch-work, an effort to keep in repair mud roads and gravel roads which have never been suitably built. No durable improvements are attempted. and the plans are those belonging to townships, as they are commonly developed by a bad phase of statute labor. While such roads are cheapest in first cost, they are the most expensive to maintain.

## Concentrating the Expenditure.

If the system of making annual appropriation is adhered to, in carrying on street improvement, the disposition of the money should be such that a certain amount of permanent roadway will be built every year, devoting the smallest sum possible to repairing unimproved streets. This, however, is not the business-like policy, the policy on which great improvements have been successfully brought about. One man never attempts to build and pay for a railroad ; but a company is formed, bonds are issued, the money obtained to be paid back in the course of a number of years. The work, as soon as finished, is an asset, to be balanced against the bonded indebtedness. The company which manages and directs the railroad expects it to earn a sufficient revenue to keep itself in repair, and to ultimately pay for itself. This is the method whereby all our greatest and best business concerns have been built up. It is the only method whereby permanent and durable results can be economically obtained. This is the method adopted in establishing municipal waterworks systems, electric light and sewer systems, and is quite as necessary in street improvement. The annual taxes should be used to pay for the interest, for maintenance, and to create a sinking fund to meet the principal when due. Improvements made and maintained in this way are not a direct financial loss. But these improvements are an asset to be placed to the credit of the town, to be balanced against the bonded indebtedness just as is the case in the construction of railroads. A town which owns a public hall worth $20,000, as a corporation is none the poorer because it is in debt to this amount for its construction. The hall is an asset which should be placed to the town's credit, balancing the indebtedness.

The principle of paying for a public work immediately on its completion is not a just one. The benefit derived from improved streets, a town hall, a sewer system, has only commenced when the work is completed. This benefit extends over a term of years and the only fair system is to ask payment from the citizens as the benefit of the work is received by them. Nor is the full benefit of street improvement derived when only short sections of street are constructed annually. It is not until the whole town is provided with well designed thoroughfares that the full benefit commences. Short sections are merely scattered links of a chain ; the usefulness of the chain is not realized until all the sections are joined, to the full length required.

## Assessments.

In assessing the cost of these improvements, the annual payments may be met by the general funds of the town, in which case, in order to render justice to all, it would be necessary to raise sufficient money to suitably improve at least the most important street of the town ; or a local improvement by-law may be adopted, this being usually framed on the frontage assessment system.

The latter system, that of frontage assessments, is one of the most suitable remedies for existing conditions. When work is undertaken by means of it, money is raised by the issue of debentures extending over a term of years. The amount is assessed against the property abutting on the work, according to the frontage of the

lot. By means of the frontage tax system sufficient money can be raised to do durable, serviceable and economical work, and it is generally the most satisfactory means of consolidating road expenditure. Money thus obtained, may be had at a low rate of interest, and, payment being extended over a term of years, the annual rate of taxation is small. The ultimate cost is no greater than under the old system of patchwork, the difference being that less money is wasted. The durable improvements obtained are at once a benefit to the property owner, the value of property is increased, and the town as a whole becomes a more desirable place of residence.

## System.

In order that the care of streets may be reduced to a system the great need of the majority of towns at present is: (1) Capable oversight, so that work will be performed on proper principles of construction and in accordance with carefully prepared plans. (2) The concentration of funds so that work of a permanent nature can be undertaken.

System, as applied to streets and pavements, is not generally understood, although parallel with the construction of waterworks and sewers. With the construction of a system of waterworks, a plan for the whole town is first decided upon. The required size of the pipe on outlying streets is estimated. Then that of the lines by which these are supplied is computed, and so on until the size of the largest mains is known, and a complete plan showing the size of all pipes required is laid down. The whole of this may not be constructed at one time, but definite provision is made, and it is constructed in accordance with the plan as required. This is the case with waterworks systems, sewerage systems, and should be the method adopted in the construction of roads. The illustration may be extended to include the raising of funds, repair and maintenance; all public work should be carried on in a business-like way, under nearly one system of management. A definite plan for the whole street mileage should be considered, and the means provided for carrying it out as required.

## Classification of Streets.

In proceeding under a proper system then, one of the first steps is the classification of the streets according to the amount of traffic over them. The principle of economic fitness between the paving material and the wear to which it will be subjected is a most important consideration.

The main business streets in the strictly business sections, naturally fall into a class by themselves, requiring the most durable class of pavement. Asphalt and vitrified brick will, in the larger towns at least, be the most desirable. It will be necessary, in the construction of these, to employ an engineer, if the town has not a permanent official, so that the details of their construction need not be dwelt upon. In case asphalt or vitrified brick are out of reach, a heavy form of broken stone driveway, will be the most satisfactory. Broken stone or gravel roadways, however, under excessive traffic, though not greatest in first cost, are very expensive to maintain, so that the ultimate cost, say after a ten years' term, may easily amount to as much or more than the outlay for an asphalt or vitrified brick pavement for the same period.

A second class of roads would include the leading entrances to the town from the surrounding country. The traffic from outlying territory is collected from numerous intersecting roads and lateral branches, until it all merges and proceeds along these entrances of the town concentrating finally

Cross-section of a Street under the Old System.

on the business streets. On such streets a strong form of broken stone roadway will generally be satisfactory, except in the case of large cities.

The third class of streets are the important laterals of the main streets and leading entrances to the town. They are the streets serving certain sections and industries of the town, and over them passes a light but frequent travel, with occasional heavy loads. A lighter and less expensive form of broken stone or gravel pavement would be most satisfactory for streets of this class.

The fourth class, and least important of all, are those of an exclusively residential character, traversed almost entirely by a few carriages, delivery wagons and light vehicles. A light broken stone or gravel pavement would answer the requirements of such streets.

As indicated in the foregoing paragraphs, broken stone and gravel driveways are those which may be used on the majority of streets in the smaller towns at least, and it is in their construction that those interested in street construction are chiefly concerned. In the case of business streets, with horses standing, moving slowly, tied and pawing, with generally an excess of traffic, a macadam pavement retains a great amount of street filth, is difficult to maintain, and should be replaced with vitrified brick or asphalt. A well kept macadam driveway is in keeping with well-kept boulevards, lawns and shadetrees, the characteristics of a residential street; it has a cool appearance, the dust can readily be subdued by sprinkling, and for light driving it is the favorite among wheelmen. Bicyclists usually favor gravel or broken stone roadways in preference to the more costly classes of pavement.

## Earthwork.

At present we ordinarily find, on unimproved streets, a row of shade trees outside the side walk, the latter being close to the fence. Outside the trees is a deep, open ditch, and between the ditches is a roadway forty feet or so in width. In commencing the construction of the street, it is generally advisable, if not necessary, to take up the sidewalks to permit a proper grading of the road allowance. The engineer should first take levels of the street, to determine the amount of cut and fill necessary in properly grading the street, and in making a sufficient excavation to receive the road metal. Care should be taken to equalize cuts and fills as much as possible and to utilize all surplus earth in filling up low lots or boulevards on the street. In this, the handling of a considerable amount of earth is often necessary to obtain the best results.

## Location of Sidewalks.

When the earthwork is finished, the sidewalks may be placed immediately outside of the row of trees, and the space originally occupied by it, sodded; and if the fences are removed, the strip is, in effect, added to the depth of the lawn. This arrangement will usually leave space for a strip of sod between the sidewalk and the carriageway. If this part of the boulevard can have a width of about three feet or more, it takes away a certain dusty, commercial appearance, which the street would otherwise retain. The sidewalk should have a distinct elevation above the sod, sloping slightly towards the roadway to provide for proper drainage. The strip of sod between the walk and the curb should have a fall towards the curb of six or more inches, and, on a twenty four foot roadway, having a crown of one foot, (bringing it to about the same elevation as the walk) this will leave from six to eight inches of curb exposed.

In the finished street, it is ordinarily advisable to have the crown of the roadway at the same elevation as the surface of the walk; and, in any case, the sidewalk should


A WELL DESIGNED STREET.

Cross-section showing sidewalks out-side the trees and roadway curbed with cedar.

not be lower than the crown of the roadway. It will be necessary to excavate below this elevation to provide for the reception of the broken stone. The depth of the excavation must provide for the thickness of the layer of stone or gravel used, and for giving it a proper crown.

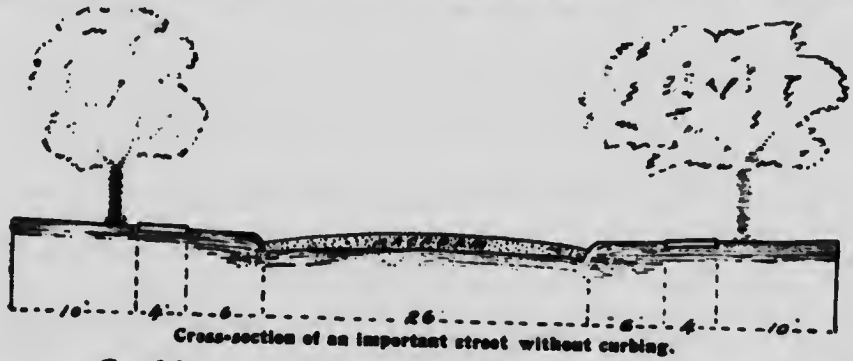
## Width of Roadway.

The present tendency is to narrow the width of the driveway. It is found that, to occupy a sixty-six foot road allowance with a four foot walk on each side, and to devote the remainder to the driveway, is a needless expense, both in first cost of construction and in maintenance. From 22 to 26 feet is, on the majority of residential streets of towns, ample to accommodate traffic. A broad driveway is very handsome, but so also are broad stretches of boulevard, nicely ornamented with shade trees.

otherwise water will stand in the roadway, soak into and soften it, and cause rapid decay; but a crown higher than is necessary to properly drain the surface of the road is also objectionable.

## Road Metal.

In most localities throughout the Dominion, good road material will be found within easy distance. There will be a choice of granites, gneisses, limestones, sandstones, field bonlders, pit and creek gravels. In some districts, trap rock, the best of road-making material, is available. The gneisses are usually harder and tougher than limestone, bnt the latter offsets this largely, by better cemeting qualities. Fieldstone makes a very good metal if care is taken in its selection. Pit gravel usually needs screening and crushing to remove sand and earthy matter, and to reduce the large




Cross-section of an important street without curbing.

## Curbing.

Before the stone has been pnt on the road, the excavation made to receive it shonld have a strip. of curbing placed on each side. Flagstone, easily obtained in many localities, is the more handsome and durable material. A good snbstitute is 3 x 10 cedar, which should be spiked to posts 2½ feet long and 6 inches in diameter, placed in the ground at intervals of six or eight feet. By bevelling the tops of the posts, the cnrbing may be inclined slightly. It presents a better apperance than when the posts are perpendicular, the tops of the posts are protected and there is less liability to decay.

## Crowning the Roadway.

A very noticeable defect of many roads as they at present exist, is the flat or even concave surface. Others present the opposite extreme, and are so rounded up as to make the road dangerously high in the centre. Roads must be crowned sufficiently to shed the water from the centre to the side,

stones to suitable dimensions. Creek gravel is often sufficiently clean to be applied directly to the road, but attention should be given to breaking large stones. In choosing material, a selection must nsnally be made between a cheaper and poorer metal in the immediate vicinity, and an expensive but more durable metal from a distance.

Cleanness of material is absolutely necessary. Sand and earth are very injurions to the roadway when mixed with gravel, as they attract and retain moistnre and permit it to pass through to the snb soil. A covering of this kind is not only less serviceable while it lasts, but is less durable than one composed of clean metal. Gravel shonld be placed on the road in layers of not more than four inches in depth, and each layer consolidated with a roller. The depth of gravel reqnired on the street varies in proportion to the amonnt of traffic. On residential streets, little travelled, eight inches at the centre and five at the sides will be sufficient. Residential streets, considerably travelled, with occasional heavy loads, will

require nine inches at the centre and six inches at the sides. On other streets, largely travelled ten inches at the centre and seven at the sides will be needed.

Stone should be crushed and screened into sizes varying from one inch in diameter to two and one-half inches in diameter. The largest stone should be placed in the bottom of the roadbed, and the smallest at the top. A road surface of a mixture of large and small stones, in time becomes very rough owing to the smaller wearing more rapidly than the larger, while the large stones at the surface have a tendency to become loose.

Broken stone should be placed on the roadbed in layers, and each layer thoroughly consolidated with a roller before the next

**Town Streets**—"Worse than the worst phase of the statute labor system."

is applied. The depth of the stone may vary according to traffic, from eight inches at the centres with five inches at the sides to twelve inches at the centre with nine inches at the sides. As with gravel, it is very important that the material should be clean. No 'binder' is needed with limestones. If an exceedingly hard metal such as trap is used, the fine screenings of the stone will be the best aid to consolidation. In rolling, the lower courses of the stone should be perfectly dry, but in finishing the road, water may be used to flush a dressing of stone screenings into the interstices.

## Drainage.

Good pavements are largely a matter of good drainage. Not that the shape of the roadway, the material of which the surface is composed, or the way in which it is laid, are unimportant—but that these are very largely a part of a system of drainage. Underdrainage is one of the first points to consider. It is the native soil which must really support the weight of traffic, no matter what material is used to form the surface. Gravel, stone, brick or asphalt are not sufficiently strong to bridge over a wet and yielding sub-soil. If this natural soil is kept in a dry state it can support any weight, and to this end, underdrainage is necessary. Underdrains may be made of common field tile, four inches in diameter, placed on each side of the carriageway, underneath the gutters, at a depth of about three feet. This "lowers the water-line" and secures a good foundation.

There must be surface drainage, and for this, the surface must be crowned, or pounded up, covered with a hard surface metal, and open gutters provided to carry away this surface water. The surface metal (gravel or other materal) resists wear so that the surface of the road remains smooth, permitting the water to flow readily to the side of the road. But a further object to be attained by the surface covering, is to have a coating that will not allow water to pass through to the natural soil beneath. By crowning the surface, rolling it to make it compact and smooth, water is at once shed to the open gutters at the sides of the roadway.

Gutters and underdrains are useless, unless outlets are provided, and care must be taken to see that these do not become ob-

structed. Surface drains may have outlets into the tile drains through catch-basins, or into the sewers, if capacity for storm water has been provided. Generally, the angle between the curb and surface of the roadway will form a sufficient gutter but with *macadamized* business streets, where horses frequently stand at the edge of the road, the gutter should be concaved and paved with cobble-stones.

Springs underneath roadways should be tapped with blind drains at the source, and the water carried diagonally across the road to the underdrains at the sides.

## Rolling.

For economical, durable, and serviceable roadmaking, a heavy roller is indispensable. A road must be sufficiently smooth and compact to shed the water readily to the side gutters. If gravel or other road metal is dropped loosely from a waggon on a soft earth foundation, water passes through into the sub-soil as through a sieve. Wheels passing over the road when in such a condition at once sink into and rut, not only the gravel but the earth beneath. Water is held in the ruts, and each succeeding vehicle renders their condition worse. The road is less durable, since, the metal being mixed with earth, the surface of the road obtains, when finally consolidated, a dusty, easily worn surface.

A steam roller costs more than a horse roller, but produces much better results. A weight of ten or twelve tons does satisfactory work, and should not be too heavy for bridges.

Rolling should commence at the side of the road, approaching the centre gradually. If the roller is first passed over the centre, the loose metal is crowded out, and the shape of the road destroyed. It is best to roll the earth foundation when dry, and each succeeding layer, up to the top dressing. When the latter is put on, the metal should be thoroughly flushed, and the rolling continued.

## Rock Crushers.

The rock crusher is one of the most important of modern additions to the list of roadmaking machines. By its use stone can be crushed so much more cheaply than by the old method of hand breaking, that, so far as the cost is concerned, stone roads are within the reach of every municipality having suitable rock in the vicinity. In the treatment of gravel, a crusher is frequently very valuable, since, if containing many large stones or boulders, it will be possible to place a crusher in the pit and pass the gravel through. A rotary screen attached to the crusher, and driven by the same power, will screen the resulting metal, removing sand and earth. Every crusher should have the rotary screen attached for the further purpose of grading the metal. This is very important, and is one of the great advantages afforded by the ma-

**Town Street Improved—East Street, St. Thomas.**

chine which cannot be secured when the stone is broken by hand. By thus grading the metal (as pointed out in the discussion of road metal) it may be placed on the road-bed in layers of different degrees of coarseness.

## Cost.

The cost of a broken stone roadway cannot be stated, as is commonly snpposed, at a definite amount for a lineal foot, square yard, or mile. An estimate, to be of value, must be made entirely in view of the circumstances of each case. The grading and earthwork needed may be very little, or may be very great. A Telford foundation may be necessary, although rarely used except in the the case of a wet sub-soil, or the highest class of work. Little underdrainage may be required ; or an elaborate system may be necessary. Outlets for underdrains and surface drains may, or may not be easily obtained. The surface metal used may be found in the immediate vicinity, requiring little treatment, or it may be necessary to bring stone a considerable distance by rail or boat. Curbing may not be considered desirable. The management may be efficient, or it may be inexperienced and wastefnl. To obtain the cost of gravel and broken stone roads from this or that municipality is apt to be very misleading. Cleveland, Ohio, has broken stone roads costing $3.65 a square yard ; but these roads have Telford foundation ten inches in depth, and are surfaced with trap rock brought from the north shore of Lake Superior. Beverley St., Toronto, an expensive form of broken stone pavement, cost about $1.00 a square yard. Under favorable circumstances, a light but good form of driveway has been bnilt for 25 cents a square yard ; for an ordinary lot of sixty-six feet frontage, with money at 4½ per cent, this would amount to $2.78 yearly for ten years, under the frontage tax system.

## The Bicycle and Streets.

This is an age of rapid transit and labor saving devices. The management of every business is looking for inventions or improvements which will produce a greater speed or economy in power. This demand has produced marvellous inventions during the present century. As a result a new species of vehicle has appeared upon the roads of the world. Like most innovations of an unusual nature it has met with much opposition and prejudice from various quarters, and like all departures of merit it is proving its worth, and is being accepted by the people as a necessity. While at one time the bicycle was regarded as a means of recreation merely, lightness of weight, facility of management, perfection of mechanism, simplicity of design, the saving of time and labor which it accomplishes and little care required makes the bicycle for the towns people at least a most valuable means of travel and in many cases, where the horse would not and could not be employed. Farmers have discovered their usefnlness and value and are using them in moving about on their farms and in frequent journeys over the roads.

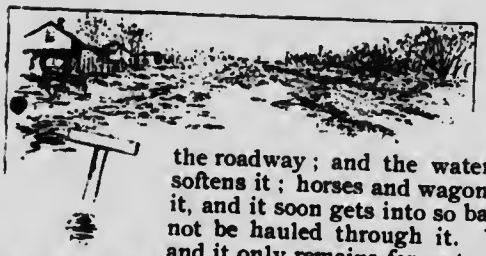
The one needful complement of the bicycle is good roads. While the horse patiently plodded through the mire road reformers received but little encouragement. The bicycle, more than any other form of carriage, has demonstrated the great loss of power, which we have suffered through the resistance offered by improperly constructed roads. Numerous mechanical devices have been manufactured to record the extra horse-power reqnired in the transportation of commodities over imperfectly built ways. The results have been reduced to dollars and cents but have been looked upon as so much dry statistics, unworthy, even in their enormity, of serious thought. But the moment human power was introduced as a means of propulsion, its importance was realized. It is no longer a mere theory, but a most stubborn fact. Smooth roads are needed by wheelmen of the towns to provide them with an easy means of travel which will extend throughout the greatest possible portion of the year. And it should not be necessary to ride three blocks in reaching a point one block away, to avoid an impassable street, otherwise there is loss of both time and power, the utility of the bicycle is defeated, and the investment therein is largely lost. The pavement which is the most suitable for wheelmen best serves the requirements of the town generally and no other investment will prove so profitable to the municipality, and the forces which strengthen the demand for better streets and the means of constructing them should be united and directed to this common end.

## What They Denote.

A town's streets should be the public lawns, the public parks. They should be to the corporation as a whole what the grass plot in front of the house is to the individual resident. There is no higher evidence of the taste and refinement, enterprise and intelligence of a community, than well paved streets, bordered with fine boulevards and handsome shade trees. Ill-kept, badly laid out streets speak of public poverty and narrowness, an utter absence of that spirit which should possess every citizen loyal to his town's interests, and wisely attentive to his own. Public streets substantially paved and boulevarded will in turn encourage a similar treatment of the private property adjoining them. There is no departure which would so instil patriotism, and love of home and country into young Canada, as the perfecting of our streets and highways.

# ROAD DRAINAGE

BY ISAAC B. POTTER,
President L.A.W.



THE first necessity of every good road is drainage. Dirty water and watery dirt make bad going, and mud is the greatest obstacle to the travel and traffic of the farmer. Mud is a mixture of dirt and water. The dirt is always to be found in the roadway; and the water, which comes in rain and snow and frost, softens it; horses and wagons and narrow wheel tires knead it and mix it, and it soon gets into so bad a condition that a fairly loaded wagon cannot be hauled through it. We cannot prevent the coming of this water, and it only remains for us to get rid of it, which can be speedily done if we go about it in the right way. Very few people know how great an amount of water falls upon a country road, and it may surprise some of us to be told that on each mile of an ordinary country highway (three rods wide), there falls each year an average of twenty-seven thousand tons of water. Water is a heavy, limpid fluid, hard to confine and easy to let loose. It is always seeking for a chance to run down hill; always trying to find its lowest level. In the ordinary country dirt road the water seems to stick and stay as if there was no other place for it; and this is only because we have never given it a fair opportunity to run out of the dirt and find its level in other places. We cannot make a hard road out of soft mud, and no amount of labor and machinery will make a good dirt road that will *stay good* unless some plan is adopted to get rid of the surplus water. To state it briefly, every country road should have side ditches—one on each side of the roadway, wherever possible.

## Side Ditches.

Side ditches are necessary because the thousands of tons of water which fall upon every mile of country road each year in the form of rain or snow should be carried away to some neighboring creek or other water channel as fast as the rain falls and the snow melts, so as to prevent its forming deep mud and destroying the surface of the road. When the ground is frozen and a heavy rain or sudden thaw occurs, the side ditch is the only means of getting rid of the surplus water, for, no matter, how sandy or porous the soil may be, when filled with frost it is practically water tight, and the water which falls or forms on the surface, must either remain there or be carried away by surface ditches at the sides of the road.

FIGURE 1.

Showing proper form of ditch to be dug along the side of the country road. The sides are broad and flaring and have slopes of "1½ to 1;" that is, the slope extends outward a horizontal distance of 1½ feet for each one foot of vertical rise.

A side ditch should have a gradually falling and even grade at the bottom, and broad flaring sides. Look at Fig. 1. It shows you the form which a side ditch should have. Its banks will not cave in. It can be easily cleared of snow, weeds and rubbish; the water will run into it easily from each side and it is not dangerous to wagons and foot travelers. It is, therefore, a much better ditch than the one shown in Fig. 2, which represents the kind of ditch very often dug along the country roadside.

FIGURE 2.

Showing form of side ditch frequently seen along country roads. The sides of the ditch are too steep and quickly "cave in" at sides and edges, thus obstructing the flow of water at the bottom. This form of ditch is also dangerous to travelers.

## The Ditch Guage.

To make the ditch shown in Fig. 1, and to make it with even, flaring sides, so as to produce a workmanlike job, we had better use a rough guage like that shown in Fig. 3.

This guage is made to fit the proper cross section of a good surface ditch, and by "fitting" it in the ditch as we go along, the shape of the ditch will be kept uniform and correct. The guage can be made of any convenient strips of wood and the dimensions are described in the text below the figure.

## Location of Side Ditches.

If possible the side ditch should be about three feet from the edge of the traveled road way, and there should generally be a side ditch on each side. If the traveled roadway is fourteen feet wide, there will then be twenty feet of clear space between the ditches; if the traveled roadway is sixteen feet wide, there will be twenty-two feet of clear space. Now and then we shall find a place where the roadway is too narrow for these figures. and in such cases we may have to get along with a single ditch and a narrow roadway. The best rule is the rule of common sense.

Sometimes side ditches are entirely omitted and the shallow gutters at the sides of the wagonway are depended upon to carry off the surface water. These gutters sometimes serve a good purpose, especially when made in regular shape and with good grade (as can be done with a good road machine), but they are likely to be clogged and destroyed by passing wagons, and for this reason alone it is better to make one or more separate side ditches when possible. When the highway space is too narrow to admit of the use of a side ditch, and in fact, in all cases, it is important to keep the angle ditches at the edge of the roadway clean and smooth by cutting out the angle and smoothing the surface; using a road machine and roller if these can be had. The work of a road machine in cleaning out an angle ditch is shown in Fig. 4.

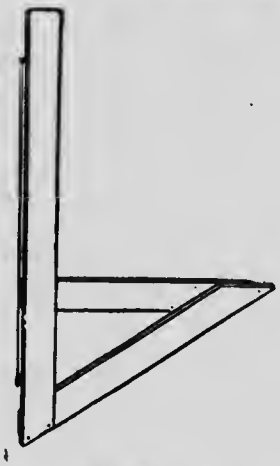


FIGURE 3.

Showing "ditch guage" to be used in making proper slopes at sides of ditch. The guage is made of light strips of wood, about three inches wide and one inch thick. The upright strip is four feet long. The horizontal strip is eighteen inches long from the left side of the upright piece (as you face the figure) to the point of guage at the extreme right, and the top of the horizontal strip is one foot above the bottom point of the guage.

Common side ditches catch surface water and surface water alone. When the surface of the roadway becomes rough and rutty by the passing of wagons, the ruts and low places hold the water and prevent its passage into the side ditches, and although these ditches carry most of the water which falls, there is often enough left in the roadway to create deep mud and produce much harm. In Spring the frozen ground prevents the water from passing downward into the soil, and it remains to form mud on the surface.

Side ditches should be kept clear of weeds, grass, brush and all sorts of materials that will tend to clog the ditch and stop the flow of water. They should be regularly examined and the greatest care taken not only to keep the ditches open, but a free and unobstructed drainage from the roadway into the surface ditches should also be maintained.

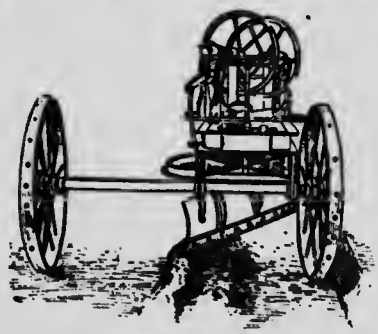


FIGURE 4.

Showing "angle ditch" at side of roadway being cleared and opened hy the use of a road machine. These machines are great savers of time, labor and money, and will open ditches, clean ont weeds and rubbish and give proper shape to a country road qnickly and more uniformly than can be done by hand work.

## Under Drains.

No way has yet been found of getting entirely rid of this mud, but nearly every dirt road can be greatly improved and a practically dry road obtained nearly the year round by the use of one or more lines of under drains. It is safe to say that there is scarcely a dirt road which cannot be so improved by under draining as to yield benefits to the farmers a hundred times greater in value than the cost of the drain itself.

Few people understand what a great amount of water is held by different kinds of soil. It has been found by actual experiment that a cubic foot of sand will retain from twenty-seven to thirty-two pounds of water; loamy clay, about forty-one pounds; stiff clay forty-five pounds and "humus" (soil formed of decomposed animal or vegetable matter) over fifty pounds. In other words, the weight of water in a cubic foot of humus, is more than one and eight-tenths the weight of the same earth in a practically dry condition, while the weight of water in a cubic foot of loamy clay is about one-half the weight of the entire cube. In most soils this water evaporates very slowly and we cannot prevent the formation of mud except by drainage.

Many miles of road are on low, flat lands and on springy soils and thousands of miles

of prairie roads are, for many weeks in the year, laid on a wet subsoil. In all such cases, and indeed, in every case, where the nature of the ground is not such as to insure quick drainage, the road may be vastly benefited by under drainage. An under drain clears the soil of surplus water, dries it, warms it and makes impossible the formation of deep, heavy, frozen crusts which are found in every undrained road when the severe Winter weather follows the heavy Fall rains. This frost causes nine-tenths of the difficulties of travel in the time of sudden or long continued thaws.

FIGURE 5.

Showing form of under drain made with field stones. The ditch is first dug and carefully graded at the bottom; then large flat stones are carefully placed at the bottom so as to form a clear passage of good size for the flow of water. The ditch is then half filled with rough field stone (with small sizes on top), and on these a layer of sod is placed with the grass side downward. The rest of the ditch is filled with earth. If sod is not to be had, fine brush, hay or straw may be used instead.

Examine the picture on page 8. The surface of this road, as reproduced, shows a variety of ailments, but the chief trouble is a lack of drainage. Thousands of miles of impassable roads may be found for weeks at a time in every province of the Dominion. Drainage is the fundamental necessity. There can be no good road without it.

Under drains are not expensive. On the contrary they are cheap and are easily made, and if made in a substantial way and according to the rules of common sense, a good under drain will last for ages. Use the best tools and materials you can get; employ them as well as you know how and wait results with a clear conscience. Slim fagots of wood bound together and laid lengthwise at the bottom of a carefully graded drain ditch will answer fairly well if stone or drain tile cannot be had, and will be of infinite benefit to a dirt road laid on springy soils. If the drain cannot be laid in the centre of the road without seriously interfering with the passage of wagons, the ditch can be dug on one side of the roadway and between the roadway and the ditch. It should not be less than four feet deep, and this depth will, in most cases, be about right. If we decide to use field stones, we should select flat ones to form the opening or channel at the bottom of the drain and they should be laid with care, so as to leave a good sized opening, as shown in Fig. 5. The method of building this drain is described briefly in the text under the figure.

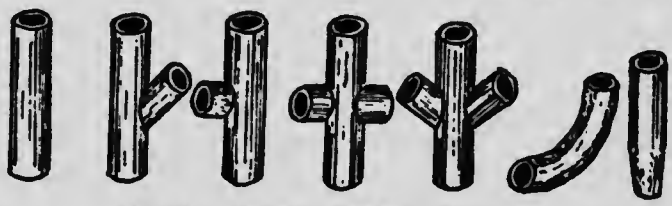


FIGURE 6. DIFFERENT FORMS OF DRAIN TILE.

## Leveling.

The use of a simple "dumpy" level or drainage level is easily learned, and the road-maker who can employ a level in his work is certain to have the best results. It will aid him in fixing and staking out grades for the roadway, for surface ditches and for under drains, rapidly and accurately, and besides insuring a better and more permanent job, it will be a source of satisfaction to him in every branch of his work. The cheaper forms of levels sold by dealers in surveyors' instruments will generally answer every purpose. There is now in the market a special "drainage level" which, by an ingenious mechanical device, is made to indicate grade at each point of the ditch or roadway without requiring the road maker to "figure it out" The appearance of the grade level is shown in Fig. 7. The price ranges from $12 upward. Full directions for using the level is contained in a handbook supplied by the maker, and it is scarcely worth while to include them here.

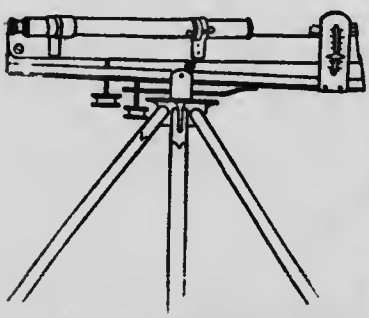


FIGURE 7. GRADE LEVEL.

## The Drain Ditch.

Before beginning to dig, lay out both sides of the ditch by two lines of stakes set 25 feet apart lengthwise with the ditch. Do this carefully. For a depth of four feet in stiff clay soils, a width of 16 to 20 inches at the top of the ditch will be about right if narrow drain tools are used. If any part of the ditch is deeper than four feet, widen the top in proportion to the increase of depth. Use sharp narrow spades for digging and cutting the sides of the ditch, and if you have much under-draining to do get a set of draining tools, or at least a ditching spade, a tile spade and a "draining scoop" or finishing scoop to use in shaping the bottom of the ditch to fit the tile. These, with a level and careful work, will be enough. If the sides of the ditch show signs of caving in, brace them with short pieces of board or plank and cross brace as shown in Fig. 10.

Begin at the lower or down stream end of the ditch so that water will run out as you go along with your work. Do not open too great a length of ditch at a time; put your tile in place as you go along and cover it. It will then help to keep the ditch dry and will make your work easier. Be very careful to keep an exact grade as you go along. A succession of humps and hollows will cause your drain to clog and will in time ruin it.

FIGURE 8.

Finishing scoop for shaping bottom of drain ditch to proper grade and of correct form to receive tile.

## Grade of Drains.

If possible give the bottom of your drain ditch a fall of at least six inches for each hundred feet of length. A fall of three inches will carry the water, but with light grades extreme care must be used in forming the ditch bottom to exact grade in every part, and the lighter you make the grade the greater will be the danger of a sluggish flow of water and the clogging of the drain.

## Size of Drain.

If poles, withes, or fagots are used (as they sometimes are when stone and tile are scarce or too expensive) they should be laid lengthwise the bottom of the ditch to a height of not less than six or eight inches. The ditch should be six inches wide at the bottom and the poles, withes or fagots should be carefully covered with sod, with the grass side down, before the ditch is filled. If stone is used, select flat pieces to form the opening, and make the cross section of channel at least four inches in smallest dimension. If tile are used, the proper size will depend on the length of the drain and the condition of the ground. If the drain is long, the soil wet and "springy" and the grade light, a five-inch tile will be about right, and whether one or two lines of tile should be used must depend on the judgment of the road maker. Under ordinary conditions the following rule may be used:

For drains not longer than 1,200 feet use a 3-inch tile.
For drains 1,200 to 2,000 feet long use a 4-inch tile.
For drains 2,500 to 4,000 feet long use a 5-inch tile.

Remember the rule, that double the diameter gives four times the capacity. A four inch (round) tile will pass more than four times as much water as a two-inch tile, because it has an opening four times as large and an inner surface (which obstructs the flow of water by friction) of less than four times the inner surface of the two-inch tile. A three-inch tile will pass about thirty-five gallons of water per minute when laid on a grade having six inches fall per hundred feet. But a larger drain is never out of place in a roadway and it is better in some ways than a smaller one. It admits more freely the warm air in Spring and hastens the thawing of the frost and the drying of the road.

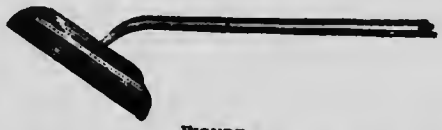


FIGURE 9.

Improved draining scoop for removing earth from the bottom of the ditch and preparing a bed for the tile drain.

## Quality of Tiles.

Avoid soft, underburned tiles, which can generally be detected by their pale color and by the soft, dead, "punky" sound given out when they are struck by a steel blade or hammer. They are likely to become softer when saturated by water, and to yield to the pressure of earth or become destroyed by frost. Avoid,

also, over-burned tiles, which, though often extremely hard, are generally shrunken, more or less warped, and difficult to lay and to match joints one with another. Select straight, hard tiles of a strong, bright cherry color, and see that they give out a clear, ringing sonnd, when struck by a trowel or piece of steel. All tiles should be assorted, before using, and the least perfect pieces should be put in the up stream or inlet end of the drain.

## Laying Drain Tiles.

If your drain fails in a single spot it fails entirely, and no drain is better than its worst laid tile. The grade cannot be guessed at or carelessly followed, and in most cases it will be best to employ a skilled ditcher to do the work. A taut line should be stretched lengthwise with the ditch and over its centre, and this line should be exactly parallel with grade of the bottom of the drain and about seven feet above it. This being done, Dr. Manly Miles, in his excellent little work on "Land Draining" * gives the following directions. than which the author can snggest no better.

FIGURE 10.

Cross section of ditch with brace plank supports to prevent caving n.

"The ditch having been dug to within eight or ten inches of the bottom, and the line properly adjusted over the middle of the ditch, two men may begin the work of finishing the excavation and laying the tiles, which we will suppose are for a four-inch main, beginning at the outlet. A level-headed boy, or the proprietor as superintendent if he does not prefer to lay the tiles himself, will facilitate the work by managing the measuring rod, and performing any other service that may be required, from time to time, outside the ditch.

"One of the men standing in the ditch, with his face towards the outlet, with the six-inch draining spade, slices off the earth, or loosens it to nearly the required depth, moving backwards as the work progresses, while the tile-layer stands facing him and throws out the loose earth with a shovel scoop, or the draining scoop, Fig. 9, as may be most convenient. When the excavation has been finished for a distance of three or four feet, the tile layer planes a groove in the bottom of the ditch with the draining scoop, to the required grade, as guaged with the measuring road, and lays two or three tiles in it with their ends closely in contact, and covers them with five or six inches of earth, on which he then stands, packing it around the tiles as he proceeds with his work. The next section of the ditch is then prepared for three or four tiles by a repetition of the process of excavation —planing a groove for the tiles—laying them and covering with earth, to form a platform on which the tire layer advances, and the same routine is again repeated.

FIOURE 11.

Workman at work in drain ditch taking out bottom with draining scoop and laying tiles as described in the text.

"By following this system, it will be seen that the feet of the workmen are not within eight or ten inches of the bottom of the ditch, the man with the draining spade standing on the earth to be excavated, and the tile-layer on his underdrained platform, as represented in Fig. 11, is exempt from the annoyances of mud and water that are usually associated with the work of draining. If the bottom of the ditch is soft, and water is running over it, the man with the draining spade will be standing in mud, which will interfere with his efficiency and the general progress of the work. This can, however, be obviated in a very simple way, that more than repays the extra trouble it involves. A one and one-half or two-inch pine plank about six feet long, and a little narrower than the bottom of the ditch, is laid down for him to stand on. Near the upper end ot the plank a hole should be bored, in which a small rope is tied, its free end being thrown over the edge of the ditch to keep it out of the mud. With this the plank can be pulled back from time to time, as may be required."

## Cost of Tile Drains.

Of course, no exact figures can be given to show the cost of laying under drains, since the expense will vary with the cost of labor, the difficulties of digging, the size of tiles used and other items; but as an approximate guide I will say that a line of three-inch tiles can be laid four feet deep for about $5 per hundred feet, including cost of tile, laying, digging and filling. Four-inch tiles can be laid for about $5.50 and five-inch tiles for about $6 per 100 feet. With good management these figures are ample and in many cases can be considerably reduced.

*Published by Orange Judd Company, New York, 1890.


Every fortnight this bright, newsy, interesting wheel paper, from 36 to 64 pages of good original matter contributed by a bright corps of correspondents in various parts of the country goes to every member of the Canadian Wheelmen's Association. It is printed upon expensive paper and is always copiously illustrated. The C.W.A. is looking for Better Roads and Wheelmen's Rights. If you are an amateur bicyclist you are eligible for membership. Will you not contribute your quota to help the good work. Full particulars by addressing

**H. B. DONLY,**
**Secretary, Simcoe, Ont.**

# Roads Improvement

The Canadian Wheelmen's Association maintains a National Committee on Improvement of Highways. This Committee wants the name and address of every person in Canada who feels an interest in the work for better roads, and of

**Every newspaper whose editor is willing to publish an occasional interesting item or article to advance the cause.**

The Committee also wants photographs of good roads and bad roads, tending to show how the good roads help business and how the bad roads injure it. We shall be glad at all times to know who our friends are and to welcome their co-operation. Send your name and address to

**H. B. DONLY,**
**Secretary, Simcoe, Ont.**

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## APPLICATION FOR MEMBERSHIP in the C.W.A.

**To H. B. DONLY, Simcoe, Secretary-Treasurer, C.W.A.**

DEAR SIR:—Enclosed you will find $1.00, for membership in the Canadian Wheelmen's Association, to which I hereby apply for admission. I declare myself to be an amateur within the meaning of the Definition of the C.W.A. I refer to the undermentioned persons.

.....
Signature.

*Address*.....

*Club*.....
If any.

*Date*.....

*References*.....

If parties referred to are members of the C.W.A. two are required; if they are not then there must be three.