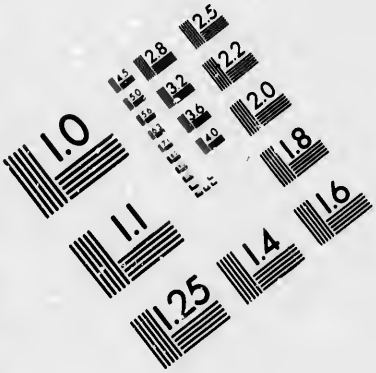

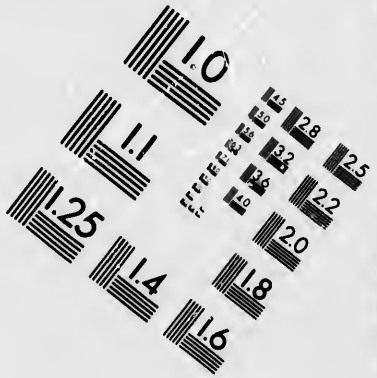

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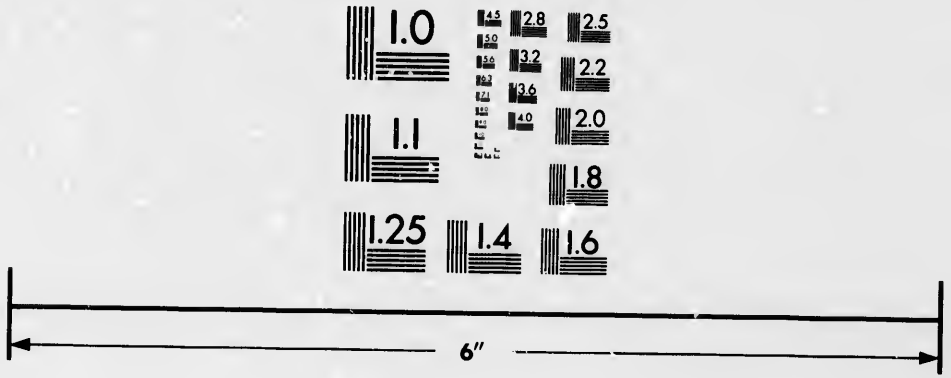

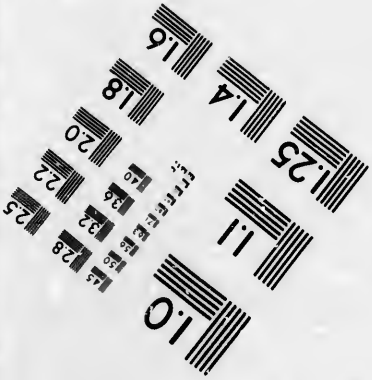

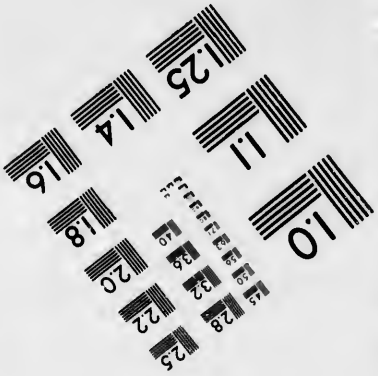

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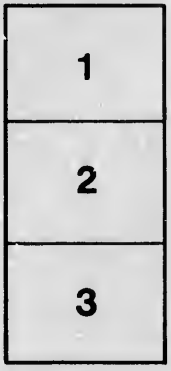

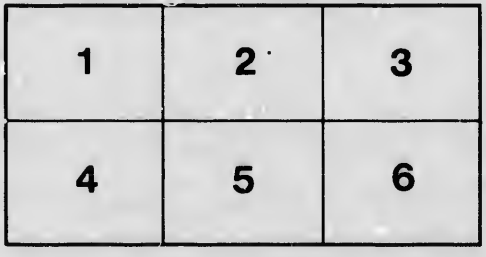

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ON THE

CONSTRUCTION OF COMMON ROADS,

TO WHICH IS APPENDED

SOME REMARKS

ON THE

PRESERVATION OF WINTER ROADS.

BY

GEORGE H. HENSHAW, C.E.

Montreal:

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1871.

Entered according to Act of the Parliament of Canada, in the year One Thousand Eight Hundred and Seventy-one, by GEORGE H. HENSHAW, C.E, in the Office of the Minister of Agriculture.

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PREFACE.

In this work the author has endeavoured not only to give a detailed outline of the course to be pursued in constructing common roads efficiently and economically, but he has also sought, as simply as possible, to explain the principles on which the various operations are based, in order that they may be clearly understood, so that those who use the book as a guide may not omit valuable details from a misapprehension of their importance.

Though common roads are universally admitted to be the chief instruments in developing and increasing the resources of a country, however intersected it may be by railways, they have seldom been thought worthy of being placed under the charge of scientifically educated men, but are usually delegated to so-called practical men, who probably never have given a thought to the principles involved in the work they do, perhaps are even ignorant that any exist.

The following pages are mainly designed to instruct those of the general public who interest themselves in seeing that the taxes they pay for roads are economically expended, as well as those of the official class who are responsible for the proper outlay, rather than to enlighten educated engineers, who nevertheless, it

is hoped, will find in them not a little worthy of their attention. Whatever of originality may be found in their perusal, the author desires it to be understood that everything of a speculative or theoretic character has been carefully excluded, he being convinced that mere opinions, unsupported by practical experience, however high their source, would detract from the value of a work whose humble but perhaps chief recommendation is that nothing is advised therein but what has been subjected to practical experiment by himself during a professional career of over twenty-two years.

It is scarcely necessary to remark that no attempt has been made to enter the wide field of street roadways, a comparison of the numerous systems of which would be tedious and invidious; the author, however, may be permitted here, after a pretty extensive observation in the chief cities of America and Europe, to record his decided preference for the asphaltum pavement, as employed in Paris, which appears to work in the most satisfactory manner, has the fewest objections, is easily and effectively repaired, and is but little affected by climatic conditions.

The reader of this book is especially desired to give his attention to the article entitled "Primary consolidation of the Roadbed."

ON THE

CONSTRUCTION OF COMMON ROADS.

ARTICLE I.

LOCATION OF MAIN LINES.

As locating a public highway is necessarily the first operation to be performed in its construction, a few short remarks upon the most important principle involved in this branch of the subject will serve as a fitting introduction to this work.

It would be very difficult, indeed impossible, in spite of its high importance, within the limits of this small volume to lay down rules which will meet satisfactorily the ever varying circumstances of different sections of country; on the judgment and skill of the surveyor must depend the correctness of the location; but as in practice the surveyor is seldom quite untrammelled in his action by local or other authorities, whose ideas on the subject are often limited to the desire of having the road pass by certain points, some information to these will, it is hoped, assist the former in convincing them that their interests may be better consulted by adopting other lines than those which they may at first have desired.

Although a straight road is in itself desirable on account of shortness, the best, and in the long run the cheapest, location through a country of diversified surface, will be found to be that which follows the general contour of its rising grounds, because such a line affords frequent and easy means of rapidly draining the roadway, and thereby preventing the formation of deep ruts and holes.

After all, the length of a road lies practically, not in the measured mileage, but in the time taken up in passing over it from place to place. No teamster or traveller would hesitate to take a good road, even if a mile or two longer, in preference to a short cut on a bad road at the risk of damage to his vehicle or horses, and of arriving at his destination late, tired, and travel-stained. The old saying, "the longest way round is the shortest way home," proves often true.

It is of course quite possible to push this rule to extremes, but, as has before been intimated, judicious variation from it must depend on the skill of those who direct the work, the true limit being the result of close comparisons of length and expense, bearing always in mind the fact that a well located road must save largely from the frequency and cost of repairs of an ill-planned one.

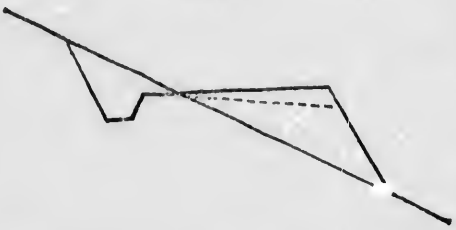
ARTICLE II.

FORM OF ROADWAY AND DRAINAGE.

THE most suitable width of bed for main or arterial

roads is found to be from twenty-four to thirty feet, and it should have a rounding of from six to eight inches in the centre, on those portions which are either straight, pass over level ground, or are elevated above the surface. When the road follows the contours of hills, a cross section of it showing part cutting and part bank (see fig. 1), the form should be somewhat different. Thus, on outer curves the outside edge of the road should have the greatest elevation, while on inner curves the surface should be nearly level, as shown by the dotted line. No drainage should ever be allowed to find its way over the outer edge ; it should fall into the inner ditch, and be led along it to its proper outlets through drains, culverts or bridges, at suitable points as they occur.

Fig. 1.



Ditches, so universally neglected, are really of the first and last importance in the economy of roadmaking. So deeply do they enter into what may be called the life principle of roadways, that two simple parallel lines of deep well made ditches, with nothing between but the natural surface of the ground, will before long produce an infinitely better and more lasting road than the most elaborately made roadbed unprotected by them, both being left to take care of themselves.

In further illustration of this point, the author may be pardoned the following short quotation from a popular lecture on the subject, lately read by him at a meeting of the Literary Society of Amherst in Nova Scotia:

"Drainage, then, is the first and all important point to be looked to. Just look at it! Did any one ever see a bad road that was dry unless on account of holes made in it previously by wet? Does it not then follow as a logical consequence that the nearer we can approach to a dry road the better it will be?* It is plain, then, that in commencing the construction of a road, the first thing to be thought of is good and effective side ditches, and the deeper they can be made the better. But this is not enough. Side ditches are intended to receive and convey water, not to hold it; we must therefore have thorough good outlet drains or ditches with as much fall as can be got, in order to empty the former as quickly as possible. But here some may say, 'We don't see that. If we keep the water well below the road it cannot hurt it; why, then, be so particular about emptying the ditches? It cannot get out upon the road again, for everybody knows that water cannot run uphill.' Stop, my good friends, everybody does not know that. Take two tumblers, one partly filled with water, the other empty, and put them together on the table before you. Now, take a piece of common wick and hang one end of it in each tumbler, and you will soon see the water run

* Ordinary clay roads were here referred to.

up hill and at last drop into the empty glass. This action is caused by capillary attraction, and the movement of water through the soil is precisely the same as that we see in the wick."

The use of unglazed tiles in the draining of agricultural lands is based on this same principle of percolation, and if the results of their action are so satisfactory where every shower is absorbed into the soil, how much more thoroughly must the body of a road be dried out when the great mass of the rainfall upon it is immediatly carried away by well graded ditches. As further evidence of the value of deep ditches, it may be remarked that the author has frequently observed on marsh roads subject to the influx of tides, and impossible therefore thoroughly to drain, that where the deepest ditches were, the road was in a marked degree freest from deep holes and ruts. These holes being due to the giving way of the thin crust of comparatively dry surface covering the moister subsoil, a deeper drainage by thickening this crust had prevented.

Where roads pass along side hills or through shallow cuts, the soil is frequently of so dry and porous a nature as to render subdrainage unnecessary; nevertheless, ditching here is almost as necessary, indeed, in many cases, if possible, more so than elsewhere, for the purpose of carrying off surface or flood water. Their neglect produces the familiar phenomenon of the water course establishing itself in an irregular free and easy

style along the middle of the road, doing more injury than is often imagined by the public who travel it, or even by those whose business it is to repair the damage, as will be shown in the article on roadbeds.

One advantage in deep ditches will be obvious to the inhabitants of countries subject to heavy snow storms, and that is contained in the fact that when snow accumulates in them, the greater part of its weight being supported by the sides, the lower stratum is relieved from the downward pressure, in consequence of which rains which subsequently fall, after penetrating the snow and accumulating at the bottom of the ditch, find little difficulty in dissolving the loose snow there, and pass away in the accustomed channel beneath the main body, which forms a protecting bridge over it. On the other hand, in shallow ditches it generally happens that the wet snow, instead of melting away, remains in a sodden state until a frost ensues, which binds it firmly in a mass of ice to the bottom, remaining a permanent obstruction during the winter, and in the spring turning the floods over the road to its serious damage.

When the fall of the ditch is great and the soil loose, the side forming the edge of the road at least should be sodded with grass ; and if the incline is excessive, a series of gentle inclines may be made with advantage by means of small dams at intervals, built up of good solid grass sods, laid with a batter and in the form of an invert to keep the flow of water in the middle of

the ditch. Figs. 2 and 3 show a longitudinal and transverse section of the ditch. A is the line of the top ; B the original bottom; C C the gentler inclines formed, terminated by the dams.

Fig. 2.

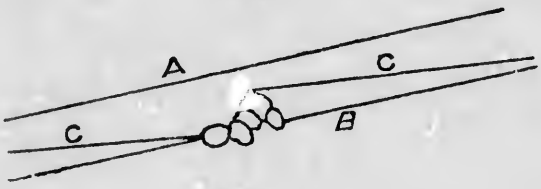


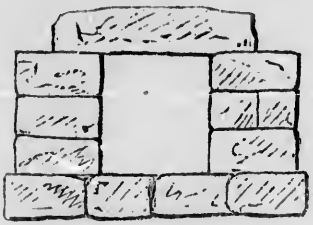
Fig. 3.

Ditches ordinarily should have a width at bottom of 18 inches, and the sides should slope at 1½ foot horizontal to 1 foot perpendicular ; but, as soils vary, no absolute rule can be given, for in very loose soils the slope would require to be greater, while in peaty ground the sides may be nearly vertical. The fall of the ditch should be continuous though not necessarily of one grade, which would often entail needless expense, but, where possible, it ought not to be less than 6 inches in 100 feet. The outlet ditches should be of size sufficient to carry off the accumulated water, and they should be cut out to the nearest available natural water course, or to such other place as will take the water clear from the road.

In crossing deep hollows or streams the ordinary bridges, of various construction, would of course be used. A description of them would be tedious and superfluous here.

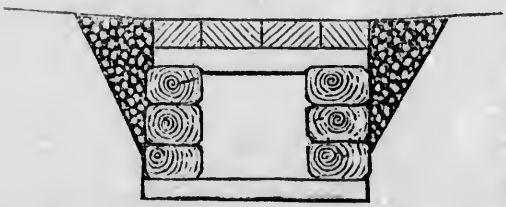
For passing moderate quantities of water under the roadway, the best means is by stone box culverts covered with large flat stones (see fig. 4) laid close together, any spaces between them being carefully packed with broken stone or spalls. The walls should be built up in courses, and as these are usually built dry, it is an excellent plan to bed each course in a thin layer of moss. The opening should be at least 2 feet square, to enable the culvert to be readily examined and cleaned out, in case of rubbish accumulating inside.

Fig. 4.



Where stone is too expensive the ordinary crib culvert, with sides of flatted sticks laid one upon another and resting on cross sleepers, may be used, and, when properly made of good material, last a long while. They ought, however, only to be used in shallow banks, the top should be brought up level with the surface of the road (rather below than above it) and be composed of plank or flatted timber packed on both sides with broken stone, as shown in fig. 5, to prevent the jolts that otherwise occur in passing over it. For small quantities of water what are called French drains may be used. These consist of a simple trench, filled in loosely with

Fig. 5.



large broken stone and protected on the top with sods brush, etc., to prevent earth from running in and choking them. It is better, however, to have the lower part of these drains hand-packed, leaving an opening at the bottom of about 6 inches square, covered with flags or flat spalls, the whole resting on a longitudinal plank for greater convenience of cleaning out, which may be done with a small scraper attached to a long handle.

Where springs exists beneath the road, or where the subsoil contains more moisture than can be effectually drawn from it by the side ditches, underdrains will be necessary.

The cheapest and perhaps best kind of these is composed of a narrow trench, deep enough to be out of the reach of frost, with 3 sapling poles laid at the bottom in the manner shown in fig. 6. Poles averaging 3 inches in diameter are found to be the most effective, and care must be taken to secure the lower pair of poles from spreading. The bottom of the trench should have as good an incline as possible, so that the water can flow freely through; the trench should now be filled nearly to the top with stones, and then be packed above with moss, sods, or fine brush and clay to prevent the entrance of surface water, which should in no case be allowed to penetrate to these drains.

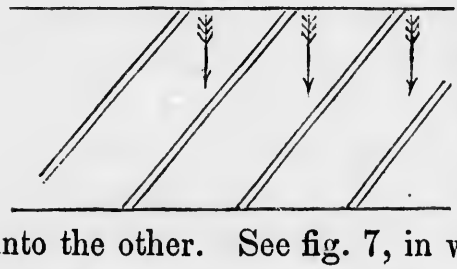
Fig. 6.

In the author's experience he has found a thin layer of horse dung, puddled in water, poured over the surface, to be the best means of sealing these drains, as it forms a sort of felted skin nearly impervious to water.*

It will of course be understood that while the outlet end of this kind of drain must be free and open, the inner end must be entirely closed and concealed, its use being solely to drain the subsoil.

For draining natural slopes, in order to prevent the undermining and slipping away of banks to be made along them, these drains are very effective. They should in such cases be run diagonally in parallel lines in such a manner as that the head of one drain shall overlap vertically the outlet end of the next, so that, moisture finding its way down beyond the upper end of the one shall fall into the other. See fig. 7, in which the diagonal lines indicate the drains, and the arrows the downward flow of the water.

Fig. 7.



ARTICLE III.

ROADBEDS.

WITH the foregoing paragraph the greater part of

* I have tried thick puddled horse dung in stopping leaks in coffer dams with perfect success, when other means had entirely failed.—*Author.*

the task which the author has undertaken may be said to be completed, for the main object of this little work is to draw increased attention to the true principles of economy to be observed in the construction and preservation of the great mass of common roads which in new countries, from the poverty of the public purse, must remain for some time unmetalled. But as population becomes denser, traffic greater, and money more plentiful, a better surface than the natural soil under most circumstances can afford will be required, and a few examples will now be given of the best forms of roadbed, commonly termed the metalling of the road.

It will perhaps be advisable here to begin with the best and most expensive form, which is that very generally adopted in European countries for their main or military roads, a section of which is given in fig. 8.

Fig. 8.

This consists of a level trench from 16 to 24 feet wide and 8 inches deep, cut along the centre of the road, and filled in the following manner :

A line of flat stones set on edge and bedded lower than the bottom of the trench, is laid along each side and rises to within 2 inches of the top of it, forming a curb to the metalling. The bottom is then laid over closely with large stones laid flat and split, if necessary

to form a firm bearing, the gaps between them being packed with smaller stones ; this layer should be about 6 inches thick. Above this is laid evenly a layer of macadamized stone broken to the size of hens' eggs, thickened at the centre to nearly the desired rounding, and brought down at the sides in such a manner that a heavy roller will compress it level with the top of the border stones. Finally, a layer of well screened gravel is laid over the whole, and the roller is once more passed over to complete the job.

The interposition of thin layers of clay between the layers of stone was formerly thought to be of advantage in binding them more solidly together, but experience has shown that they are a disadvantage excepting in a case which will be noticed in another article.

The cheaper forms of roadbed consist of modification of the above, first by omitting the border stones, then the trench, and finally the foundation layer, in which latter case the macadam layer may be made coarser, but it is of the greatest importance that the stones composing it be of a generally uniform size. This rule should indeed be strictly observed in all cases and in every layer, as on it depends the regular settlement and evenness of the whole bed ; for it is evident that when heaved by the frosts of a northern winter and relaxed by thaws in the spring, the larger stones will not return to their places as quickly as the smaller. These latter, under the pressure of heavy loads, are driven by the wheels below the larger stones, holding

them up while they go down; and thus we have the process by which the ruts and holes which so commonly disfigure roadways are mainly formed.

In all cases where metalling is used, it is necessary to the formation of a good road, that sufficient material be first delivered on the spot to complete an entire section, however short its length may be, before beginning work, and that the uniformity of the layers may be preserved, no traffic should be allowed over unfinished work.

A certain excess of gravel, moreover, should be allowed to remain in small heaps along one side of the road for repairs, the importance of which precaution will further on be more fully explained. It may here be added that roadwork should always be done in the dry season.

The author has succeeded in producing an excellent roadbed very cheaply on a heavy clay soil by the sole use of screened or sharp gravel free from sand. It was first laid on in a layer of about 3 inches thick and 8 feet wide along the centre of the road, the surface having previously been levelled. This, as it was driven down by the traffic, was also from the same cause spread out to a greater width on each side. A new layer was now added above, about 10 feet wide, and the result was to produce naturally what in the cases before given is produced artificially, a solid crown along the centre of the road with a fall to each side. Besides securing a great degree of permanency much material

is saved by this mode, which is usually kicked into the ditches by the horses' feet when the whole width is laid on from the first.

In concluding these remarks on construction, it may be as well to observe that wherever from neglect or other causes, during the work or after, depressions forming pools of water on the surface appear, they should at once be drained out by cutting a notch straight across the road ; this will prevent the rapid increase of an evil which is otherwise sure to occur from the puddling of wheels in the softened bottom.

If it was more generally felt that he who thus prevents the formation of a slough of mud is as great a benefactor to the public as the famous individual who made a blade of grass grow where none grew before, no doubt many would become interested enough to stop a moment on their way and do a bit of work that would give them very little trouble, but would save in the aggregate an immensity of discomfort to their fellow-beings.*

To compel traffic to pass over the newly laid metalling, it is common to use logs laid at convenient intervals across the bermes on each side. The best means for this purpose is a stout pole bored with two augur holes at right angles to each other, at one end,

* The author has often "done good by stealth" in this way (though he cannot add the rest of the quotation) by merely scratching a little channel with the heel of his boot, or by removing an obtrusive sod of grass with his walking-stick.

Fig. 9.

through which are driven two wooden pins or bars (see fig. 9) which serve to elevate that end of the pole something in the manner of a common saw horse. These barriers are very convenient, not easily lost, and retain their position better than an ordinary log. They should be painted or whitewashed to be readily seen at night. A good roller will, however, to a great extent, prevent the necessity of using these barriers, by removing the nuisance to the public of hauling through the loose metalling.

A careful consideration of this branch of the subject must convince all of the economy of using rollers. Without calling into the question the vast increase in ease and comfort to those who use the road, a consideration which alone might be thought to be sufficient, there is a great saving both in material and in securing greater solidity to the mass, because the angles of the stones are wedged firmly into each other at once by the pressure, instead of being worn off and broken up by the long process of being driven down by traffic.

Where good granite quarries are accessible, an excellent roller can easily be made. It should be about 3 feet or 3′ 6″ in diameter and 4 feet long. Its surface should not be straight but slightly hollowed to assist in giving the proper rounding to the road. Where

suitable stone cannot be had, an iron cylinder may be substituted, but it is usually inferior to stone from the absence of the hollowed surface, which is difficult to cast.

ARTICLE IV.

PRIMARY CONSOLIDATION OF THE ROADBED.

THE term primary consolidation is here used to express that consolidation which should ensue immediately on the construction of the roadbed, in distinction to that which follows after its lengthened use.

Hitherto we have confined our attention to the actual construction of roads with the details belonging to each branch of work as they successively present themselves in practice. We must now consider a point in the economy of their preservation which, though involving some extra expense, and therefore very rarely attended to, is of the utmost value in preserving the roadbed. In this point lies the sole security we have against the destruction of the new bed, or at least against the necessity of more or less heavy expense in repairs. Every experience has but added confirmation to this view of its importance. The author has seen not a few examples of second-class roads being raised practically to a first-class rank by following out the principle involved, and of roads built in a first-class manner completely cut up through its

neglect. He would therefore consider this work far from complete, if he neglected to press upon the reader its vital importance.

In a former part it has been remarked that evenness of mass and regularity in thickness of the layers composing the metalling were necessary to secure a permanently solid roadbed. The reason for this was said to be that when roads are metalled irregularly or with heterogeneous material, the loosening of the mass, particularly in spring thaws, would cause the weaker parts to yield under traffic sooner than the rest, so that while this yielding would tend still further to weaken these parts, the same action would strengthen the adjoining parts by underpinning them, resulting, of course, in a broken and rutty surface. On the other hand, if material of a perfectly homogeneous character could be obtained and laid with mathematical exactness, it is plain that the whole surface, being of equally graduated strength, would settle evenly without exhibiting irregularities. As this, however, is impossible, it behoves us to see how the important object which it would secure may be obtained in a practical as well as practicable way.

Fortunately it can be got at in a thoroughly satisfactory manner, and at an expense, considering the great subsequent saving, of a very trifling amount. The need of surplus metalling left in heaps along the side of the road has been before adverted to; we are now to see how to make use of it.

Before we begin, however, let us glance at the road as it now stands. The construction work is completed and the road opened to traffic. A stretch of neatly rounded roadway lies before us with its broad stripe of metalling occupying the centre, presenting a smooth and compact or loose and roughened surface, according as a roller has or has not been employed. The road is finished, says the public, and so, unfortunately for tax-payers, have said ninety-nine out of a hundred of those who have had such works in charge. No, the road is not finished. To abandon it at this point is to strike the centring of an arch before securing the keystone. We will now proceed.

A gang of men, in numbers, according to its length and traffic, should be retained and distributed singly at suitable distances along the road. The duty of these is to watch for every depression, however slight, made by the traffic, and immediately repair the same from the material at hand, effacing as far as possible the tracks of the wheels, so that succeeding vehicles may not follow in the traces left by those which have gone before. They are also, under the direction of the foreman, to place or remove the barriers already described so as to divert the traffic whenever this is found at any place persistently to follow one line. Thus the whole surface will gradually become consolidated, and the weaker portions brought up to a uniform strength with the rest. The small expense attending it, and the rapidity with which a firm smooth surface

will by these means be obtained, will surprise those who try it for the first time.

The surface will now be so regular that one vehicle will find it next to impossible to follow the track of another, even if so disposed, and the road may at last be abandoned with safety for a considerable time. Nevertheless, those who desire to preserve their roads permanently should retain enough force, either constantly or periodically, to prevent their running down, and in any case the reserve heaps of metalling should not be allowed to disappear. The great point, as will be observed, is never to permit the crust of metalling to be broken through. Once a rut is formed it is not likely ever again to be restored to its former condition. Its base is forced below the level of the surrounding bed. It is repaired by filling with fresh stones. A hard knob is formed which remains fixed when the neighbouring surface is yielding, and it thus becomes a sort of nucleus for other ruts which it forms around it, like a cancer, spreading destruction to the whole road.

As a corollary to the above the reader will recognize the intense stupidity of the practice so common in country parts of filling up ruts in unmetalled roads with stones. If it should become necessary to repair holes in a road during wet weather, some perishable material as brush should be used after the water has been drained out.

ARTICLE V.

CONSTRUCTION UNDER EXCEPTIONAL CONDITIONS.

Up to this point we have regarded our road as being constructed through or over the more or less clayey formations which compose the greater part of the habitable portions of the globe. We have now to consider what ought to be done with other soils, frequently and often extensively encountered.

Gravel soils need scarcely be referred to; they form of themselves natural roadbeds. Ditching, however, is as necessary to them as to other soils, to prevent the scour of their loose material by floods.

Where rock is encountered, sufficient channels should be made at the sides of the road, so that floods may not wash out the smaller stuff from the crevices and leave the surface rough and broken.

In sandy soils an admixture of clay or almost any other material is of advantage, and when metalling is used a thin layer of clay, the drier and more comminated it is the better, should be placed between each layer of metalling. These clay layers should not be so thick as to conceal entirely the metalling below. A clap with the flat of a spade should be responded to by the clear click of the metalling. This is the only case in which layers of clay in the metalling can be recommended.

The marsh soil which extends along the upper shores of the Bay of Fundy is, though in a less degree,

common elsewhere. This soil, varying from a firm sandy clay to a clayey sand, almost a quicksand, may be treated successfully in the usual manner. A different opinion, the author is aware, is entertained by some of the inhabitants of the region above-named, but after lengthened observation he has not been able to find a single instance of failure where the principles here advocated have been observed, or where the plan actually adopted would not equally have failed in any of the common clays. It is proper to say, however, that with this soil the ditching becomes of peculiar importance, and if possible greater emphasis should be laid upon this branch of construction than with other soils.

Swamps and morasses are usually crossed by means of what is known as corduroy roads. These are very common in the Southern and Mississippi States of the American Union. They are made by simply cutting down the neighbouring trees, and clearing them of their branches, dividing them into suitable lengths and laying them close together crossways of the road, the spaces between being filled with small poles or the branches cut off in trimming the trunks. Such roads serve their purposes as temporary expedients, but those who have once travelled over them, especially after they have become decayed, never desire to repeat the experiment. The system, however, is so cheap that it is not very likely to be superseded; but the plan usually adopted is susceptible of great

improvement. When the bog is deep large trees should be used, and the road be made as wide as possible to gain buoyancy. Small poles should be laid on top to fill out the hollows between the logs, and a thick layer of small brush stripped from the branches, or composed of alders or other straight-growing underwood, laid over the whole. Above the brush a layer of clay thick enough to compact it should be laid, or, if this cannot be had, the natural soil of the bog may be used, but the layer of brush will then need to be thinner. It is almost always advisable to lay down three or more rows of poles longitudinally of the road as bearers to rest the logs upon to prevent irregular settlement; these poles need not be large. The surface of such a road when once dry is elastic and agreeable, and as the weight put upon the logs is supposed to be sufficient to sink them nearly below water, while what remains above is covered with brush and soil, the road will be found to last a long while. No attempt at side ditches should be made, because useless and even injurious.

When the swamp is of such a character that it can be drained by side ditches and outlets, small poles below the brush instead of logs, even the brush alone, carefully laid, will answer best; they should in all cases be well covered with soil, as the irregular rotting of the brush tends otherwise to form ruts.

Once come to a bearing, these roads may be gravelled with excellent effect, if done in dry weather.

The best metalling for this purpose is shells, large deposits of which are found in many sections of country, and furnace cinders, but ordinary sharp or screened gravel will do very well. Slate or any laminated stone is excellent, and, from the elasticity of the bed on which it rests, lasts remarkably well.

APPENDIX.

BEING SOME REMARKS ON THE PRESERVATION OF WINTER OR SNOW ROADS.

It has occurred to the author that a few suggestions on the topic given in the heading to this article, in the form of an appendix to this work, may be acceptable to the reader if only on the grounds of inciting more general inquiry into a matter of widespread interest, and of eliciting more fully digested views on the subject.

In northern countries, the value of good snow or winter roads is well known and recognized, and their early opening and late preservation are matters of great interest to the general public.

In the construction of public works, as well as in lumber and other trades, the facilities of winter transport influence largely the estimates of cost, the haul of heavy material being greatly cheapened, and often made possible only when the snow has interposed its slippery surface and buried beneath it the obstacles and inequalities of the ground. Nevertheless, those who are in the habit of observing must frequently have felt that much more than has hitherto been attempted

might be done to extend the duration of winter roads, and, at the same time, improve their character..

As a basis to the observations about to follow, the author has taken the evident facts that on all roads a large portion of the snow fall is wasted in drift heaps, which serve only to increase the difficulties of travel and remain long after sleighing becomes impossible, keeping the road in a sloppy condition, or else, as is particularly the case on elevated banks, the snow is swept from the surface and the roadway laid bare. The problem then to be solved would seem to be, how to prevent this drifting and reduce the snow fall to a general level. It need scarcely be said that no complete solution of this problem is here attempted, but a step in the right direction, it is hoped, will be attained.

Drift heaps appear to increase more in proportion to the violence of the wind than to the size of the producing obstacle. In woods the snow lies level, and such is also the case in lanes bordered with well clipped hedges, hence it would seem advisable to encourage the growth of a close belt of trees along the sides of the road,* or the more difficult task of planting hedges and keeping them in order.

In live hedges thorns are preferable to evergreens,

* An objection to trees on the sides of roads appears, strangely enough, to obtain in many places. The author has several times been consulted as to the advisability of cutting down trees said to shade the road and keep it wet, but he has always replied that surface moisture is of advantage to a road, providing good under drainage is secured.

because, from the absence of leaves, they offer less resistance to penetration, and consequntly diminish the force of the wind above them. Palings are best for straight fences, but snake fences are better than post and rail, as they can be entirely levelled to the ground, which is often done in the Lower Province of Canada on the approach of winter.

Close board fences, which should at least be fourteen feet high, have been found effective, but they are expensive and require to be very strongly braced to resist the wind. The principle of this kind of protection is that if the fence is high enough the wind wave will recoil upon itself and form its drifts behind the obstruction, but its utility in a great measure ceases after a certain amount of snow has accumulated.

Detached houses ought to be built far enough back from the road to prevent the formidable drifts they create from obstructing it.

When fences must be left standing their tops should form continuous lines, unbroken by post caps or other projections.

Experiments might be tried in convenient localities for the purpose of testing a plan of a new form of roadway which appears likely in most cases to prove efficient.

This plan consists in forming the roadbed in two levels, that is to say, in making a berme on one or both sides of an ordinary road between the main roadway and the ditch, which shall be about a foot lower than

the former. The idea is suggested by observing that portions of a road, which had accidentally assumed this form, retained on the lower level a good winter surface long after the higher parts had become bare.

A frequent annoyance in winter travel is caused by the absence of snow from the surface of banks which cross valleys and ravines, leaving long bare stretches to be painfully dragged over. This difficulty is sometimes sought to be avoided by fixing low bulwarks at the sides of the road; but as the wind does not always blow transversely, the result often is that but a small and insufficient quantity is drifted along the edges. A better remedy will be found in the substitution of rows of good sized boulders, laid close side by side. The effect of these is to form little low rib-like drifts across the roadway, which not only retain their position tenaciously, but also serve to catch and retain the snow when the shifting of the wind drives it longitudinally of the road.

As drifts, however, rarely occur during the actual snow storm, but are in most cases caused by high winds succeeding it, an additional precaution may without great trouble be employed, namely, that of "breaking the road" in the usual manner with large flat-bottomed sledges during the storm instead of after it. This plan would not in heavy storms obviate the necessity of a second "breaking," but it would certainly facilitate that operation, and the snow thus compressed would successfully resist the eroding effect of the winds.

In spite of all precautions, the uncertainty of winds must often upset the best laid plans for preserving good winter roads. In climates like that of Lower Canada, where the snow fall is great, inconvenience from absence of snow is rarely felt; but in the Upper and Maritime Provinces, where thaws and rains commonly alternate with the snows, it is often the case that an otherwise good road is interrupted at frequent intervals by short stretches of bare ground, to the great hindrance of traffic.

Generally some provision is made for remedying thisnuisance, either by what is known as statute labour, to which all the inhabitants are liable, or by laws compelling residents or owners to repair the roads opposite their properties. But these regulations are in practice seldom vigorously enforced, to do so would require an energy and fearlessness on the part of those charged with the management rarely to be found among men who generally hold their positions on political grounds, and are therefore unwilling to incur the ill-will of their neighbours.

Now, without repealing these laws or regulations, or attempting their better enforcement by multiplying penal clauses, a careful consideration of the impulses which govern human nature would seem to indicate that a very effective means exists for arriving indirectly at the desired result.

It is a proverbial fact that men will do of themselves, on an emergency or for their own interest, that which

they will shirk or resist to the utmost under compulsion.

If then, in addition to what we already have, a law be passed (with a moderate fine for its neglect) to the effect that every teamster or common carrier driving a loaded sleigh shall carry with it a shovel, it will soon be found that, rather than exhaust his horses and lose his time, he will without legal coercion make use of it. Once in possession of the means, the use will not be slow in following. Carriers are of course the class most interested in good roads, and among them the law would be easy to enforce, for a natural jealousy of each other would induce them to look out that none take advantage of their work without doing their share of the labour.

To conclude: two things necessary to place all road matters in satisfactory working order are sadly needed. 1st. The non-political appointment of able and energetic managers; and, 2nd, A public sufficiently alive to their own interests to pay them enough to give their whole time to the work, and to sustain them in carrying out their plans.