of stationary thought the universities indubitably have been, like the monasteries, that they succeeded as centres of learning; and they have thus served as the guardians It is necessary only to good earth bank's run gravel a

been, like the monasteries, that they succeeded as centres of learning; and they have thus served as the guardians of a treasure that is beyond all price. But this is only half the truth; for it has long been one of our most cherished ideals that universities should also be the natural homes of original discovery and productive scholarship. The real universities—and I believe that our own is one of them—have demonstrated by their example that the atmosphere which these things create make teaching live and move."

GRAVELLED ROADS.*

By Gabriel Henry,

Chief Engineer of Highways, Province Quebec.

THE nature of the top course to be adopted for a road depends, more than anything else, upon the traffic which it is destined to accommodate. It is useless to insist upon this fact, so well established by experience and now so generally admitted.

The cost of top courses varies according to their qualities and powers of resistance, and the more solid and durable they are made, the more expensive, as a general rule, they are. In cities, it is usual to employ a series of paving having the greatest powers of resistance and of duration, but which are too expensive for the country districts.

On the trunk roads connecting the different cities and forming the country's principal arteries of circulation, resort is had to pavings or top courses of concrete, brick, bituminous macadam, water-bound macadam with or without a bituminous carpet. The choice of these different top courses depends upon the nature and the Importance of the existing and future traffic, as far as the latter can be foreseen. These top courses are also all of them relatively costly and require careful maintenance. They are only used where absolutely necessary. But outside of the cities and of the trunk roads there are a number of less important roads. The total length of these latter is generally much greater than that of the principal arteries above mentioned. They are really local roads, connecting different villages and giving communication with these villages and with railway stations, factories and trunk roads to the farmers scattered throughout the country districts. The traffic on these roads is much less important than on the trunk roads and in the cities, and from the economical point of view costly top courses are not to be recommended for them.

When the soil is of good quality and gravelly, they are maintained as earth roads. But when there is good gravel, as frequently happens, it is sometimes preferable to make use of it. And it is the utilization of this gravel for improving earth roads that we are now about to consider. Even when stone is abundant it may be advantageous in some cases to prefer gravel, provided, of course, that the volume of traffic does not exceed certain limits.

*Paper read before the Third Canadian and International Good Poads Congress. It is necessary to remark, however, that this refers only to good earth roads covered with a top course of bank's run gravel and not what is generally called gravel macadam roads. The gravel macadam is constructed like

ordinary macadam, but with certain special precautions. As this lecture treats only of ordinary gravelled roads, macadam will not be dealt with.

Surface Drainage and Underground Drains.—One of the advantages of well-constructed gravelled roads is that they can be made to serve later as foundations for a more costly top course and one of greater resistance, if traffic increases and if circumstances demand it. This fact is worthy of special attention.

Just as gravelled roads may serve as foundations for water-bound macadam or for a top course of still greater resistance, so earth roads serve as a base for gravelled roads. That is to say, that in order to construct a gravelled road it is first necessary to establish a good earth road; in other words, to prepare first of all a suitable substruction.

Before gravelling a road and when all the principal earthworks have been made and the road straightened, the curves improved and the bridges and culverts constructed it is necessary to be assured:—

(1) Of a perfect drainage of surface water.

(2) Of a suitable drainage of subterranean waters.

These two conditions are indispensable for any road, no matter what covering may be chosen for it. To attain this end it is necessary:—

(1) To create a complete system of ditches so as to rapidly drain the water from the heaviest rains and from the melting of the snow in the spring. The grade of the different ditches of this system, their dimensions and their form, should be such that no stagnant water remains a few hours after rain, and that this rapid drainage causes no erosion at any point.

(2) To inspect all places where subterranean waters soak into the sub-soil and remain there, and to drain them off by means of subterranean drains emptying into the ditches or by other means; to lower the highest level to which water rises and remains in the substructure of the road to at least twelve or eighteen inches below the surface of the road before it is gravelled.

There are many means of obtaining this result, but the study of these means does not enter into the programme of this lecture.

The large earthworks, the bridges and culverts, ditches and drains once completed, the levelling of the surface and slope of the road should be proceeded with. A large part of this work may be advantageously done with the road machine.

If a steam roller or horse roller can be obtained for this purpose it may be employed to consolidate the surface of the road and to ascertain that there remain no soft spots or places not properly drained.

It must be remarked here that it takes some time for the drains to give the expected result. In certain soils it is sometimes necessary to wait many months before the effect is felt.

If by means of the roller soft, damp spots are found, they must be drained and hardened before the gravel is laid.

It is as necessary to insist on this question of surface and subterranean drainage for gravelled roads as it is for earth roads, and even more so. Just as an earth road may be called upon to receive a covering of gravel or other top course, so a gravelled road may later be called upon to bear a covering of macadam. It is, there-