

THE GRADING AND DRAINAGE OF ROADS.

DETERMINATION of the amount of grading to be done in connection with the improvement of any highway depends upon the amount and nature of the travel and the topography. Excessive grades increase the cost of transportation and also add a heavy burden of maintenance, and it is always advantageous to lengthen a road and eliminate an excessive grade. This, as a whole, should be governed by the axioms enumerated by S. D. Foster, Chief Engineer, Pennsylvania State Highway Department, in his paper to the American Road Builders' Association in December last. These axioms may be stated as follows:—

1. No greater load can be moved over a highway than is moved over the maximum grade.
2. It is generally true that a road over a hill is equal in length to one around the base.
3. If the tendency of the topography is toward a continued elevation, the grade line should never be allowed to have a descending grade, and vice versa.

Sacrifice of straightness or of grade will be dependent upon the predominant nature of the travel. Where horse-drawn vehicles predominate, alignment should give way to the lessening of the grade, as horse-drawn vehicles demand easy grade in preference to straight roads; where motor travel predominates, the grades should give way to alignment, for the rapidly increasing use of motor vehicles places a new responsibility upon the roadmaker—the reduction of danger to life and property, which necessitates building highways with long, easy curves.

Drainage.—In determining the amount of drainage it is well to remember that the ability of earth or soils to sustain loads depends largely upon the moisture present. Most soils can be compacted to form a good, firm foundation as long as they are kept dry, but when wet they become soft and in a great measure lose their sustaining power. The main problem, therefore, in the construction of a highway is drainage, which is dependent upon proper location. If the ground is level and not subject to flood there is seldom difficulty in location, but marshy ground underlaid with quicksands is expensive to deal with and generally should be avoided, even though it involves a considerable detour. A quicksand well drained often makes an excellent foundation for a road; the drainage, however, must be thorough and rapid. If the ground is level and subject to flood, mainly by backwater, an adequate number of small drains will usually accomplish the desired result, except that it may cost a good deal to raise the grade of the road above flood level. Cases sometimes arise where it is more economical to build a road floodproof at a lower level and submit to an occasional interruption of traffic than to make a wide detour or go to the great expense of a fill or viaduct.

Roads Subjected to Floods.—If the ground is level and subject to floods running at high velocity great care is necessary. The natural channel of the stream is altogether insufficient to carry the flood water, and, if the bridge crossing the stream is made large enough to permit the flow to pass under it, extensive erosion is liable to take place. If overflow bridges are built they are very likely to cause formation of side channels. Usually, the best treatment is to build the bridge large enough to pass the whole stream in flood time, straighten and widen the channel of the stream as much as possible, remove obstructions and protect the banks at exposed points.

In some cases it may be necessary to allow the flood water to overflow the road at some points, which must, of course, be made floodproof. Where such overflow

points are provided, they should be made long and shallow to reduce as much as possible the velocity of the current flowing over them; otherwise adjacent property will suffer unnecessarily. These low places should also be so located as to reduce the actual damage to the minimum, as it is the duty of the public official to protect the just rights of all parties. If the proposed road crosses a narrow valley with a rapid stream, it is almost always best to give the bridge ample waterway and fix the grade above the reach of high water, taking care, of course, to protect all exposed points against erosion. Where valleys are to be crossed it is always better to cross them where they are narrow and the streams rapid. Such conditions reduce the amount of embankment required and also the span of the bridge, requiring more substantial construction, but proving more economical and more enduring.

One other condition met with frequently upon the highways of Pennsylvania is that arising from the tendency of one stratum of soil to slip upon another and thus cause landslides. These are most difficult and expensive to deal with, and it is seldom if ever worth while to attempt to hold such a movement of earth in place by piles or retaining walls. The only sure treatment is the thorough cutting off of the water before it enters the sliding mass. French drains with suitable laterals are generally better than tile drains, the usefulness of which may be destroyed by a slight movement in the slide. The drainage must be ample, as regards the sizes and lengths of the drains and the sufficiency of the outlets. This is sometimes a very expensive treatment, but if well done a permanent cure is generally effected.

The Ontario Government has secured an option upon timber rights in a large section of the limits of the Pembroke Lumber Company in and immediately adjoining the Algonquin National Park. The limit taken over, and by order-in-Council brought within the park, is chiefly valuable to the province from the fact that it contains a splendid stand of young pine. The price to be paid by the Government is \$185,000.

Repairing a Locomotive with Portland Cement.—The Chesapeake and Ohio Railroad Company have successfully used Portland cement for the temporary repair of a fissure, 3-in. long, in the steam chest of a locomotive engine. Cement was employed because the part affected was inaccessible for the customary treatment. It is stated that after having been in service for eight months, the locomotive was sent to the shops for general overhauling, when the cement lining was found to be so perfect that it was left in place.

The conference of the International Waterways Commission just concluded at Washington, D.C., has resulted in the decision of the commission, first, to employ leading sanitary engineers to study the problem of the pollution of boundary waterways, then to give them a hearing, which will be in New York about the middle of May. After that hearings will be held in the various cities and towns affected, Buffalo and Detroit, as the two largest, being the first to be visited by the commission. The commission will meet again at Sault Ste. Marie on May 4th to investigate the water power project which American and Canadian concerns desire to build at the point, and which will affect the level of Lake Superior.

Sir Robert Perks, the English contractor, has received a contract from the Russian Government to build what will be practically a new harbor at Vladivostock. The port has deep water and other natural advantages, but so far little has been done for its improvement by the government under the Czar. Some time ago the Russian Government undertook to double-track the great Trans-Siberian Railway from the Pacific to St. Petersburg, and that work being now near completion, attention is turned to the proposed terminals which will cost millions of roubles. The contract which Sir Robert is soon to enter upon will comprise accommodation for both war vessels and merchant shipping and the contractor has several years to complete the work.