

## ENGINEERING DEPARTMENT.

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## Roads and Roadmaking.

The continuous and serious consideration which has been given to the good roads question demonstrates in a very forcible manner the urgent necessity felt throughout the country for material improvement in our lines of highway communication. Even in portions of the country sparsely settled and possessing comparatively little wealth, the movement has met with distinct encouragement, and an interest in it has been developed which increases with a continued examination of the question. It is true that there are portions of the country that may never be in a condition to invest in the highest quality of highway construction and maintenance, but there is probably no portion which will not at least indirectly feel the beneficial effects of the movement, and be encouraged to improve the roads to the highest degree possible. The great advantage, however, which is to result, will accrue to the numberless suburban and rural communities which possess ample wealth for the construction of the very best highways, and whose members have sufficient business capacity to realize the sound judgment involved in the investment.

Whatever enthusiasts may say about the necessity to any country of improved roads, the principles governing the expenditure are precisely the same as those which govern any business enterprise, and the money cannot be wisely applied unless the future benefits will justify the action. There is no doubt but that many sections of the country are already in a condition to be largely benefited by improved means of highway communication involving very considerable expenditures. This is not only true of populous suburban districts, some of which have spent large sums of money on their roads, but also of a great many rural centres of population, and of other sections of the country in which only improved main lines of highway between centres of business or between these centres and railway points, would be justified. A rational system of education of popular sentiment and dissemination of reliable information regarding the various roads, the construction and comparative cost of each is more needed than anything else at the present time. There seems to be a general feeling that with a certain appropriation in hand, the only thing to be done is to spend it. It is a mistaken idea that good work must necessarily be beyond the reach of the average city or town. An ordinarily poor gravel may be used to advantage for light carriage traffic, and require but few repairs, while it would go to pieces in a week under heavy teaming. Mention is made of a road where gravel stood in good shape for six years under the ordi-

nary travel as a cross street, and failed entirely in a few days with the traffic of a main road diverting into it. This street was repaired easily after the extra travel was removed, and has since been in good condition with a smooth hard surface. It is folly to cover a road with broken stone under such conditions, at an expenditure of fifty cents a square yard, or with granite blocks at \$2 a square yard when gravel costs but ten cents. If the gravel road was subjected to traffic sufficiently heavy to wear it out in one year, then the comparative value between it and a macadam road would be different. Assuming that the gravel road would cost ten cents a square yard to build, that a macadam road lasting five years could be built for fifty cents, and will require twenty-five cents a yard for rebuilding at that time, the cost of the gravel road at the end of ten years will be one dollar a yard, while the macadam will be seventy-five cents. Where sand and gravel underlie a road which is moderately elevated, no special precaution need be taken to carry off the water, as it will pass downward quickly to a depth where it can do no harm. If a road is constructed over a clay or loam foundation, then the only safe method will be to put in suitable drains. If the ground is level or rises on both sides, one drain should be placed on each side, while if the road traverses the side of a hill, one drain constructed on the up hill side will cut off all ground water and prevent its passing under the road. Whatever method be used, it should connect with a main drain or watercourse.

When the ground is wet and there is considerable depth of loam or fibrous soil, it will probably be the safer plan to use large stones if they are near and plentiful for the double purpose of foundation and drainage. The sub-grade should be thoroughly compacted by rolling. If necessary gravel should be laid upon it before rolling, to prevent the soil from pressing up among the large stone. Blind drains should be built by excavating longitudinal trenches from two and a-half to three feet deep, and ten or twelve inches wide, to be filled with broken stone, coarse gravel screenings or pebbles. A small porous drain tile is usually placed in the bottom of the trench, and the stone tramped over it thoroughly to prevent any further settlement of the surface. In placing the large stones for the surface of a Telford road it should be borne in mind that they are to act as a foundation, and must transfer weight of the load from the soft sub-grade. They should be placed as close together as possible and have a good flat face to rest on. The smaller end should be upward, and the interstices should be filled with wedged shape pieces driven in solidly. Such points as may project above the proper line should be broken off with hammers. The foundation course must then be evened up by the use of smaller stones, and rolled until no settlement occurs. In case the road lies in a heavy

clay it may be well not only to put in a Telford bottom as already described, and also to build blind drains which will remove all water quickly from the sub-grade. The wearing surface may consist of broken stone or gravel, which will make a good road provided the traffic is mainly in light spring vehicles. Some grave's are made up of angular pebbles and material which bind the stones so firmly together that they must be picked from the bank with considerably difficulty and labor. This gravel taken from the bank and used directly on the road without rolling, will result very soon in a smooth hard road. Some light travelled roads made of this material have been in continuous use for twelve years with no repairs, and are yet in good condition. In few cases, however, can our gravels be used economically on main roads over which there is much travel. Nearly all gravel pits now in use contain more or less stone from the size of an egg upward, with quite a large percentage exceeding two and a half inches in diameter. No stone larger than two and a half inches should be used within four inches of the surface in the construction of a road. The general tendency is for these large stones to work to the surface and make a very rough uneven road after it has been in use a short time. A good road can be built of gravel by first screening out all that will pass through a one inch screen, and will not pass through a three inch screen. The foundation should be rolled until thoroughly consolidated. Screenings should be placed on this bottom and covered with one or two inches of gravel that has passed through the one inch screen; the gravel should contain a small portion of hard pan or soil of some kind as a binder. The whole roadway should then be rolled until it becomes hard and smooth. Fine gravel will then make a good road. If the travel is at all heavy, the small stones crush up quickly, and the surface becomes uneven and muddy. It is very doubtful if in a few years a gravel road will not cost as much as macadam road, and it can never be as enduring. It is not only the duty of the road master to build well, but it is as much his duty to build economically. As a general rule the main thoroughfares throughout the province can be built and maintained with broken stone for less money than with any other material. By far, the greater part will require no special provisions for under-drainage. In other places their surface has been covered with gravel, until the later has mingled with the original soil and formed a solid mass. In these instances a roadway of broken stone from nine to ten inches deep can be constructed easily and cheaply maintained. It may be necessary to remove the existing top in order to make the proposed roadway conform to a desired cross section, but under no other condition should a hard surface be broken up. If the surface is found to be hard the broken stone should be put directly on it; if loose and rutted it should