

ties. The effect of changing the roads from bad to good in a dairying district is at once plain. The milk is carried over smooth roads expeditiously from the dairy to the factory, with the least possible exposure to the sun, and least amount of churning in transit. The milk can be drawn from a larger area, the cheese made in larger quantities, factories fewer but larger, and manufacturing expenses thereby reduced, while a uniform quality of cheese is produced.

There is difficulty in arriving at exact conclusions with regard to the economic value of good roads, because of the absence of complete and reliable data. There are impediments to our reaching a complete solution, in the fact that the different benefits of good roads will combine, act and react upon one another so as to materially alter relative conditions. Ease of traction, longer hauls, more rapid travel, fewer horses, saving in wagons, harness horseflesh; increased rural population; less congestion in the cities; increased land values; greater profits on the farm; better business and social facilities, will all unite toward the one end in enabling us to live well and more wisely. The people of the American continent have, to an abnormal extent, turned for their ideals to city life. The greatest ultimate benefit which good roads can confer is to bring us back from the towns which men have made, where brick walls, stone pavements and odors of filth have shut out our remembrance of field, forest, stream, sky and nature's God—this is not the least desirable of economic results.

Culvert Tile.

The use of Portland cement in building construction is of growing interest to the engineer. New applications are constantly being suggested, and its adaptability to varied circumstances is one of its most valuable characteristics. Wireless telegraphy, the Röntgen rays, and many other of the later discoveries have been flashed upon us unexpectedly, out of the darkness. Unlike these, the wide range of applications of Portland cement have grown before us slowly, out of a gradual experience, until, massing them all together, this material has become one of the wonders of the day.

While the broader view of the situation brings to us something of amazement, it is in detail that we as builders must, for practical purposes, consider it.

Its use in roadmaking affords a view of some of its most remarkable qualities, but it is to only one of these applications this article will draw attention, a seemingly very humble use—the making of tile culverts. The number of these culverts on country roads varies greatly. Ordinarily half a dozen are needed to each mile of road if proper drainage is provided. The result has been that in constructing and maintaining a large number of wooden openings under the roads, very many

townships have annually spent a considerable portion of their expenditure available for road purposes. These small culverts are themselves constantly out of repair, forming an obstruction to travel and the free use of the roads. The end has therefore been two-fold, in that they absorb so much of the money available for road improvements, and at the same time display almost human ingratitude by their obstructionist tactics. There are not a few townships in the province which annually spend on small culverts one-half or two-thirds of their annual road appropriation. It is not the least of the good offices of Portland cement that it promises to aid highway improvement very largely in this respect.

The manufacture of concrete tile for culverts is a very simple matter, and can be undertaken by the municipalities themselves, although in a number of cases they are now manufactured as a private enterprise.

The implements required are of the simplest kind. The most important are two steel, spring cylinders, one to set inside the other, leaving a space between the two equal to the thickness of the finished concrete pipe. By "spring-cylinder," it may be explained, is meant such a cylinder as would be formed by rolling a steel plate into a tube without sealing the joint. With the smaller of these cylinders the edges overlap or coil, slightly, but are so manufactured that the edges may be forced back and set into a perfect cylinder. With the larger, the edges do not quite meet, but may be forced together and fastened. Accompanying these molds are bottom and top rings, which shape the bell and spigot ends of the pipe.

The two cylinders, with joints flush, are set on end, the one centrally inside the other, and on the bottom "ring," which in turn rests on a firm board bottom. The concrete made of first-class cement and well screened gravel in the proportion of one of cement to three of gravel, is then tamped firmly into the space or mold between the two cylinders. The tamping-iron used to press the concrete into place is so shaped as to fit closely to the cylinder.

The concrete is allowed to stand in the mold for a short time, when the cylinders are removed; the outer and larger cylinder by removing the clamps, and allowing the edges to spring apart; the inner cylinder by removing the fastenings, so as to allow the edges to again overlap, returning to the shape of a coil. The outer cylinder having thus been made larger, and the inner one smaller, they can be readily taken away, and the concrete pipe is then left until thoroughly hardened. For the larger sizes, the two halves of the outer cylinder are usually hinged, and can be more carefully removed than when allowed to "spring" from the concrete.

Just such a number of pipe as are actually required for the season's work

need be manufactured; the implements required are inexpensive, and the pipe may be made by the municipality for actual cost, which, after a little experience, can be reduced to a small amount.

The concrete adheres closely to the metal, and to overcome this it is necessary to keep the molds well oiled. This should be done after each tile is made, and when the molds are by this means kept clean, a smooth and uniform pipe of good appearance is obtained. A good mixture for oiling the molds is composed of two parts of machine oil to one part of coal oil.

To secure a durable pipe, it is necessary to exercise much care in mixing the concrete. Portland cement should be used. If gravel is used, it should, first of all, be clean. Any earthy material, clay, or vegetable mould, will certainly create a flaw in the pipe which will lead to an early destruction, and durability is the quality most desired. The gravel should be of such a size that it will pass through a one-half inch screen and should be of varying sized grain, in such proportions as to make a compact mixture. The gravel forms the greater part of the mass of concrete, and it is evident that the result will depend very largely on the quality of the gravel.

The materials should be mixed in the proportion of one part of Portland cement to two parts of gravel. They should be first turned over in a dry state until thoroughly intermixed and of a uniform color. Water should then be added. This, like the gravel, should be clean, and there should be just enough to moisten the mass of concrete. An excess of water tends to injure concrete in various ways, and is especially to be avoided in the manufacture of tile, as the tamping cannot be properly performed, when too much water is used. When the water has been added, the mixture should be made uniformly moist, by turning it over about three times with a shovel. The concrete is then ready to be placed in the molds, in which it should be firmly and vigorously tamped.

Just enough concrete should be mixed, as can be put in the molds before the process of setting has commenced, and it is therefore of importance to know how long a cement can be worked before setting begins. Ordinarily it is best to mix just such a quantity as will fill one mold at a time. Remnants of concrete which have commenced to set should be thrown away, and under no circumstances should they be worked up again and used, as they are certain to cause a defective pipe. Defects which do not appear until after the tile have been placed in a culvert and covered with earth, cause not merely the loss of the pipe, but a considerable outlay for labor which is wasted. The concrete should be handled quickly. Two men are needed, one to shovel it into the molds, and the other to tamp it.

Until the concrete has hardened sufficiently the molds should not be disturbed.