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For THE CANADIAN ENGINEER:

ROAD ENGINEERING.

BY W. H. BREITHAUPT, M. AM. SO. C. E.

(Continued from June number.)

Special care is required to provide ample section in culverts for the water which they are to pass. Too small a culvert will bank the water and flood the roadway. On the other hand, if the culvert is too large the cost of construction is unnecessarily increased. The cross section of a culvert depends on the maximum rate of rainfall on, and the condition of the soil of, the watershed, the culvert drains, on the form of the mouth and inclination of the bed of the culvert, on whether it is permissible to bank up the water and discharge under head, etc. Culverts are made of wood, brick, stone and vitrified sewer pipe. Wood is perishable and not to be recommended. Brick or stone should be used where a large opening is required. For a smaller one sewer pipe makes an efficient culvert. If one pipe is inadequate, two laid side by side can be used. The ends of the pipe at the side of the road-bed should rest in masonry retaining walls.

On completion of the grading of the road-bed, it is either simply rolled to a uniformly firm surface, or, what is better, a foundation course is put on. In this connection it may be stated that one of the most necessary tools in road-making is a road-roller. It is almost indispensable, as well for the road-bed as for compacting the surfacing. The characteristic of Telford pave-

ment is a foundation course of large stones. This is, however, by no means an absolute requisite for a good road, as even Telford recognized. Stones 7 or 8 inches deep are set on edge as closely as possible. The interstices are filled with spalls, wedged in, and the whole is then rolled to compact the mass. This compacting is very important, as is also the use of angular stone. Rounded stones cannot be held to place, but will eventually work to the top and destroy the road.

The roads in Central Park, New York, are among the best and most carefully constructed examples of Telford road to be found anywhere. Their cost, however, prohibits their extensive imitation. In Macadam pavement proper the foundation course is omitted. Macadam did not use it, but put 12 or more inches of broken stone directly on the soil, a method now conceded to be wasteful as well as otherwise unsatisfactory.

No vegetable, perishable, or yielding matter of any kind must be allowed to remain on the road-bed. Clay road-beds should be topped with a 10 to 14 in. layer of some material which absorbs little water, such as broken brick, clinker or furnace slag, ashes, or coal dust. This can be made very compact by rolling. Clay, roughly made into small lumps, and burnt like brick, a material used in some places for railway ballast, makes an excellent road foundation. On soils other than clay a 4 in. layer of sand, well rolled in, should be used in the absence of other foundation. Such a sand layer is also beneficial on top of a foundation course. The topping of the road-bed, whatever it may be, should in every case be thoroughly rolled. Before this is done it should be sprinkled, as the material then compacts better.

The width of the wheelway, i.e. of the road proper, on main lines of traffic, should not be under that required to allow two vehicles to pass each other safely, viz., 16 ft. Lesser traveled roads do not require this width. The road should always be made higher at the centre, so as to shed water freely. A rise comparatively small, in view of what was formerly considered necessary, is sufficient. The transverse contour of the surface should be either a section of a circle, or a parabolic curve. The latter is to be preferred on account of its greater convexity at the sides of the road. A straight slope from the centre outward should not be used, as it will wear hollow, and the road will then retain water. For gravel surfacing the rise at the centre of the road should be one-fiftieth of the width, for broken stone one-sixtieth, giving for a road 16 ft. wide 3.8 inches and 3.2 inches respectively, of centre rise.

The proper transverse contour should always be given to the topping of the road-bed, so that the surfacing can be in a uniformly thick layer. For a road-covering or wearing surface good gravel is very serviceable, though not as good as broken stone. The fitness of gravel for roadmaking depends mainly on its binding properties. Two of these are the presence of ferruginous clay, and the sizes and angular shapes of the stones. River gravel, gravel from the sea beach, or