

To allow the water collected by the side drains to flow in the natural watercourses from the upper side of the road to the lower, culverts are needed. The size of the culvert should be proportional to the greatest amount of water it will ever be required to give passage to, and should always be large enough to admit a boy to clean it out. If square, eighteen inches each way, and, if circular, twenty inches in diameter, is sufficient for this purpose. Wood should not be used in the construction of culverts, as the alternate wetting and drying to which it is subject is peculiarly conducive to rapid decay, and the weakness cannot be noticed until it makes itself felt by some disaster to life or property; besides, it is a source of much annoyance to traffic to have to take the side of a road while a culvert is being built.

Culverts should be made so as to last as long as possible, and for this reason, if not as a matter of economy, they should be built of stone, concrete, or brick. Where stone can be obtained conveniently, it will be found to amply repay the extra cost of construction by its solidity, permanence and consequent safety. The floor should be made of concrete, or of small stone grouted with cement, to provide a bed that the water will not wash out, and to render the cleaning-out easier.

The walls should be built on a solid foundation, got by digging down to the solid clay, and should always go below the flooring. The mortar used should be made of cement, as it best resists the action of water. The floor should be concave, and have an inclination, towards the outlet, of one in one hundred and twenty to one in thirty.

To prevent the flooring from being undermined, the stones should be sunk on edge across the upper end of the waterway. To protect the sides, end walls are built a few inches higher than the road to prevent the water from washing over them. They are inclined at a suitable angle to the longitudinal section of the road.

The length of the culvert should be the same as the distance through the road on a line with the crown of the arch, which should always be low enough to allow a thickness of six to ten inches of road-covering on top, preserving the proper height of road.

A culvert properly built will never need repairing, will be always perfectly safe, and of no expense, save for cleaning out once or twice per year.

In excavations it is not advisable to leave open drains at the sides, as they would quickly fill up with the clay washed down from the banks. Covered side drains are much to be preferred. A sufficient cross-section of waterway should be constructed of rubble stone, and the drain then filled up on top with broken stone. This will allow the entrance of the water and prevent that of dirt.

The upper end of this side-drain should not be left open, as sticks, leaves and dirt will enter with the water and soon choke up the drain. A blind drain, three to five feet long, should complete this end, unless it be a case of cutting a short hill, when there will be a fall both ways, and, of course, such a precaution would be unnecessary.

To prevent the sides from washing down, they should not have a grade of more than two to one, or in extreme cases one to one. The banks of hill-cuttings, when the work is under the direction of non-professionals, are always left too steep, the object being to save the expense of making the cutting wide enough at the top.