

## Engineering Department

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### Concrete Culvert.

The accompanying cross-section of a concrete culvert shows a cheap but durable form of structure, suitable for certain locations, more especially where not much distortion by frost may be expected, and a firm base for the side walls can be obtained. The cost would range from \$3.50 to \$5 per lineal foot of culvert, according to the availability of gravel, amount of excavation and other details. Thus a 20-foot culvert would cost from \$70 to \$100, and a 30-foot culvert from \$105 to \$150. It can be adapted to any location where stone masonry walls with a flag-stone top could be used, and is a parallel case, in which artificial stone or concrete is used in place of natural stone.

In this type of culvert, the principal matter to guard against would be a break in the cover stone. There is no difficulty for short spans up to at least six feet in proportioning the thickness of this cover for any possible load to which the culvert would be subjected. The principal cause of failure would arise from the displacement of the side walls by frost, which might break the cover stone; or expansion from heat in summer might be another cause. Both of these difficulties would be overcome by having a complete separation between the cover stone and the side walls, so that the cover stone would be merely resting on them, and not united with them. This would permit a certain amount of play for the abutments, and would provide for contraction and expansion. The objection to this is that there will be a weight on the side walls from the embankment, and to have them united with the cover would counteract this pressure.

If the situation of the culvert and the nature of the soil is such that it appears advisable to have the cover and side walls united, this can be accomplished by laying the cover before the concrete on the top of the side walls has become set.

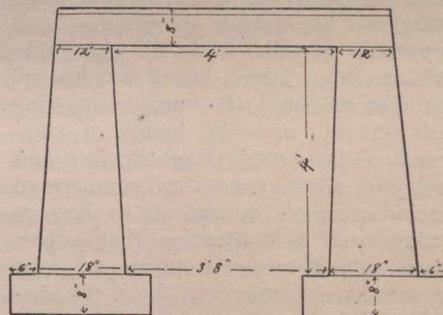
Care should in every case be taken to see that the side walls are carried to a sufficient depth to a secure foundation. The depth indicated on the drawing is sufficient only in favorable situations, where a layer of hardpan, firm gravel or rock is close to the surface. The greater the span the more necessary there is for a deep or solid foundation.

For culverts of greater span, say six or eight feet, the strength of the cover stone would be much increased by fastening iron bars length-ways with the tops of the walls, and to this attaching barbed wire, stretched back and forth across the culvert, and which should then be fully imbedded in concrete, as close as possible to the bottom of the cover stone.

It is better that a layer of earth six inches or more in depth should be over

the top of the cover stone. If this is impossible, and the top of the culvert must be level with the road surface, the cover stone should have a finishing coat rich in cement, in the proportions of one part of cement to two of sand. Otherwise a culvert of this description may be made throughout of Portland cement and gravel mixed in the proportions of one of cement to six parts of gravel. The following is a suggested specification for such a culvert, which should be modified to suit special circumstances:

(1) The culvert when completed shall be in all respects in accordance with the plan hereto attached. Should it be necessary to extend the side walls to a greater depth to a secure foundation, they shall have a top width of twelve inches as indicated, an inside batter of one-half inch to the foot, and an outside or frost batter of one inch to the foot, the footing to project six inches beyond the bottom of the wall.



CONCRETE CULVERT CROSS-SECTION.

(2) Sufficient earth shall be excavated to permit free access to the work, and the proper placing and removal of the framework. Where the excavations furnish more material than is required for the embankment, the surplus will be used to increase the width of the embankment, or otherwise removed as may be directed.

(3) The abutments are to be erected within a substantial and well constructed framework of well-fitted lumber, closely boarded up against the work as it proceeds. Care shall be taken to make a smooth, regular surface, such that moisture will not find lodgment. The concrete shall be perfectly rammed into place so that all surfaces shall be smooth, without cavities, when the casing is removed. The framework shall not be removed in less than fourteen days from the completion of the work.

(4) All cement employed in the work must be of a favorably known brand of Portland Cement, and approved by the superintendent in charge of the work. It shall be delivered in barrels or equally tight receptacles, and after delivery must be protected from the weather by storing in a tight building or by suitable covering. The packages shall not be laid directly on

the ground, but shall be placed on boards raised a few inches from it.

(5) The concrete shall be composed of gravel and Portland Cement mixed in the proportion of one part by measure of cement to six parts of gravel. The concrete shall be mixed on a platform placed close to the work by first spreading evenly a layer of gravel, upon this shall be spread a proportionate quantity of cement, and the two thoroughly intermixed in a dry state. To this sufficient clean water shall be slowly added, and the whole again thoroughly mixed and brought to the consistency of a stiff mortar.

(6) Should the gravel contain an excessive amount of sand, loam, or other objectionable material, it shall be screened to remove such sand and earthy matter. The concrete shall then be composed of one part by measure of Portland cement, two parts by measure of approved sand, and four parts of the screened gravel. It shall be mixed on a platform close to the work, by first spreading evenly a layer of sand; upon this shall be evenly spread the proportionate quantity of cement, and the two thoroughly mixed in a dry state. To this water shall be added and the whole thoroughly mixed and brought to the consistency of a stiff mortar. The proportionate amount of screened gravel shall then be spread evenly over the mortar and thoroughly intermixed therewith. The concrete, when mixed as described, shall be immediately put in place and thoroughly pounded and rammed until it is perfectly and uniformly solid, moisture appearing on the surface.

(7) Should the cover stone of the culvert be on a level with and form part of the surface of the roadway, it shall have a wearing surface one and one-half inches in depth of sand and cement, mixed in the proportion of one part by measure of cement to two parts of sand, the sand to be clean, sharp, of varying sized grain and free from loam, earth or other impurities. The sand and cement shall be first mixed in a dry state, then sufficient water shall be added to properly moisten, and the whole shall again be thoroughly intermixed. This top coating shall be applied to the concrete base before the latter has set, so that a perfect bond between the two shall be secured. The surface shall be floated and trowelled until smooth and even, and shall be marked into blocks 4 inches by eight inches to give secure footing to horses.

(8) While the work is in progress it shall be so arranged that a steady supply of mixed concrete shall pass from the mixing box to the point where it is to be placed. At any time when the work is interrupted before its completion, or at the end of the day, a wet covering shall be placed over the last layer of concrete; before the work of depositing the concrete is resumed, this surface shall be thoroughly flushed with water to remove any foreign material which may have gathered thereon. No concrete shall be laid in wet or freezing water.