CONCRETE CULVERTS.

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(Continued from last week, p. 827.)

The Old Rail Culverts.—The old rail culvert is not one in very general use, but is used, more or less, as a substitute for the regular reinforced beam or arch culvert. The Oregon Short Line Railroad uses box and arch culverts reinforced with steel rails.

In the box culverts the rails in the cover plate are spaced close together under the tracks and further apart towards the ends. The rails are all set base downward and the side walls are well battered to give wide footings.

In the arch culverts the rails are laid alternatively base and head downwards and are bent as nearly as possible to the shape of the arch. The spacing of the rails is the same as that for the box culverts. Under the centre, where the spacing of the rails is closest, two parallel strips of expanded metal are embedded on the intrados. The side and wing walls are braced together by cross walls of concrete, thus holding the filling of gravel or rocks in the invert.

The concrete used in the culvert is mixed in the usual proportions of one, three, six for such structures, Portland cement and broken stone being used.

I-Beam Culverts.—This is a type of culvert quite extensively used on the Canadian and American railroads, and is particularly used and useful where a wide culvert opening is necessary on account of a low elevation of grade above stream bed and where a large waterway is needed.

The accompanying figure (Fig. 9) shows a construction adapted for culverts, cattle passes, drainage ditches, etc., ranging from ten to fifteen-foot spans. The arches are usually quite flat, the twelve-foot arch having a radius of sixteen feet for a chord of twelve feet and corner curves of two-foot radius to the face of the abutment, which has a batter of one in twenty-four.

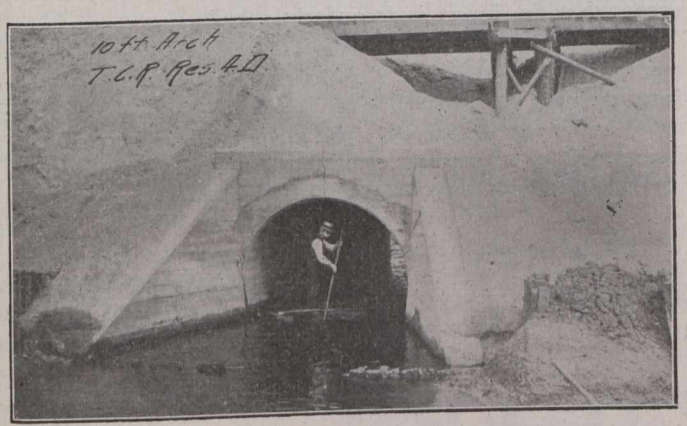

Fig. 9.—Typical Railroad Culvert With 10-Foot Opening.

For single track the length of the culvert is nineteen feet, and twenty feet and a half over the parapet walls. The thickness of the concrete at the crown of the arch is eighteen to twenty-three inches and five lines of ten to twelve-inch I-beams, sixteen feet long, spaced two feet apart, are placed under each track, embedded in the arch with about three inches of concrete below and eight inches above at the crown.

The upper surface of the arch is made to form, with the parapet walls, a basin or trough in which the ordinary ballast is laid, thus allowing the roadbed to be continued unbroken over the structure. The wing walls may be built straight or flaring, as desired. The invert is laid with a twenty-six-foot radius and scouring may be prevented by apron walls at the ends.

The culvert shown is one of this type with a ten-foot opening, and contains about one hundred and ninety yards of concrete.

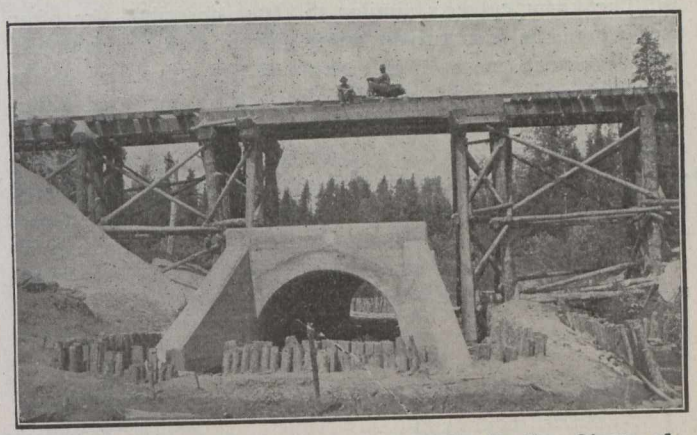

Fig. 10.—Typical Railroad Culvert in Earlier Stage of Construction.

The Box Culvert.—Flat slabs for culverts resting directly on the abutments are used in spans of from four to sixteen feet. Box culverts for railroad work are similar to highway culverts, but must be built to carry the greatly increased loading coming upon them. The side walls are usually reinforced so as to withstand earth pressure due to dead and live loads. When the abutments are sufficiently heavy at the base for this wall, it may be designed as a simple slab supported at top and bottom. Thus the walls may be greatly reduced in thickness over what is required for a wall of plain concrete.

It is frequently, depending on the material on which the culvert is built, necessary to carry an inverted slab continuous between the side walls to provide ample bearing for the heavy loads coming on these foundations. When such a floor slab is used it should be of the same strength as the cover slab, with the bars inverted in the top of the slab. Wing walls, when used, may be designed the same as for an ordinary retaining wall.

In calculating moments in box culverts of this type, a live load is assumed of 50,000 pounds on axles, five-foot centres, and 10,000 pounds per foot of track. This load may be taken as distributed uniformly over ties eight feet long. The manner in which the live load will be distributed when it reaches the culvert cover will depend on the character of the embankment.

It may be assumed that the line of zero stress in the embankment, due to live load, follows a slope of one-half to one, which is much more nearly vertical than the ordinary angle of repose. For fill of less than two feet, the impact allowance should be one hundred per cent., between two and four feet, seventy-five per cent.; above four feet an allowance of fifty per cent. may be made.

Let P_L = unit pressure on cover per square foot due to live load.

Let P_D = unit pressure on cover per square foot due to dead load.

Then $P = P_L + P_D$

Total load per linear foot = 10,000 pounds, and adding 50 per cent. for impact = 15,000 pounds.