CONSTRUCTION OF CONCRETE BRIDGES

A new situation has grown up within the past few years in regard to bridge building. Timber has advanced in price until almost prohibitive, while the use of steel and concrete has developed. It is not surprising, therefore, that much uncertainty has arisen in the use of concrete and steel for highway bridge purposes.

There is frequent request for standard plans for bridge construction, in the belief that bridges are merely a matter of span. This is true to a limited extent only. So long as timber was being used and temporary construction was being followed, present requirements only had to be considered; but concrete and steel are permanent types of construction. Concrete, in particular, is a material that will last for centuries. When materials of this class are being used, it is highly important that they be used with skill, in order that the future generations will not regard them as an eyesore or a joke. Every bridge possesses more or less individuality, according to the site and location. The placing of wing walls, the amount of water-way to be provided, the fixing of the height of the bridge, the type of superstructure, the requirements of the foundation and many other details should be considered, in order that our works represent to future generations, as well as our own, the skill and knowledge we have actually attained.

The line between a culvert and a bridge is not definitely drawn. By some the difference is considered a matter of size; by others, bridges are regarded as pertaining to flowing streams, culverts to drains.

Short-span waterways, while capable of rough-and-ready methods, are also capable of treatment that will make them an ornament rather than a disfigurement to the King's highway. A good appearance is not a matter of expense, but of good workmanship in design and construction. Neat culverts are merely a matter of good taste and good judgment, such as every progressive farmer tries to show on his own property.

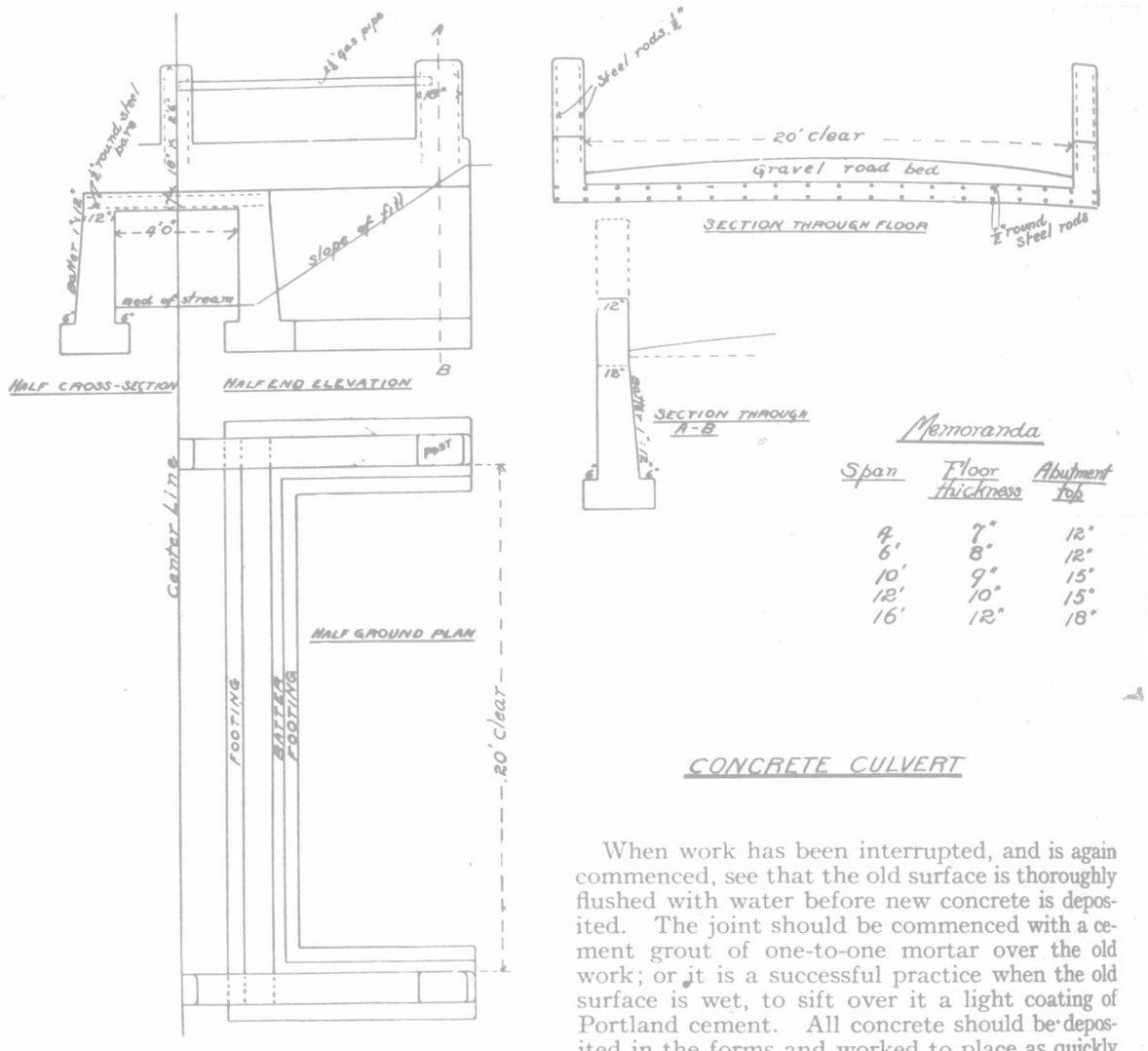
The smallest waterways may be made of concrete tile, and when well laid are durable and serviceable. Tile culverts should have end walls of concrete extending below the frost line. These walls serve several purposes. They retain the earth at the end of the culvert, prevent water flowing outside of the tile, keep the ends from being washed out and undermined.

There is a tendency to use tile where culverts of larger size should be used. The area of waterway should provide, not for the ordinary flow, not for the average spring freshet, but for the maximum rush that may occur in a term of years. Unless this is done washouts are certain to occur.

For waterways of larger size than tile culverts, the accompanying sketch will indicate a plan suitable in many cases. Simply described, it is made up of two side walls, with a slab of concrete over them. End walls are also provided to retain the earth, supporting the hand-rail and acting as wing walls. In numerous cases, to provide for the rush of water, it may be necessary to place the wing walls at an angle with the barrel of the culvert; but walls parallel with the roadway are much more desirable where the situation will admit of them.

In all concrete work there is a tendency to failure because of carelessness on the part of workmen. Every precaution should be taken to use clean sand and clean gravel; to use good Portland cement, and to see that all materials are thoroughly mixed. Use clean water. The strength of concrete is as much dependent on the other materials employed as it is upon the Portland cement. Thorough mixing cannot be too strongly insisted upon. The sand and cement are first to be mixed dry. The mixture of sand and cement should then be mixed with the gravel or broken stone, and water afterwards added to make a moist mixture. Wet concrete is preferable to concrete that is too dry, but a happy medium should be aimed at. Concrete should be just so wet that when placing it in the moulds a smooth surface can be secured. This smooth surface should be obtained by forcing a spade between the concrete and the form-work, permitting the wet mortar to flow behind the spade, and thereby obtaining a smooth face of fine material.

In getting a good surface finish on concrete, the process just described should be followed.



DETAILS OF CONSTRUCTION OF CONCRETE BRIDGES

No dependence can be placed on a coat of plaster over a rough mass of concrete. The plaster is certain to discolor, and will sooner or later scale off. To remove the marks of the timber form-work, it is well to take down the form-work from the exposed faces as soon as the concrete is hard enough, and rub the face over with a flat brick or stone.

It has been stated that concrete should be made of Portland cement, sand and gravel; or in the place of gravel, broken stone may be used. For concrete floors, such as are required for the culvert shown in the accompanying sketch, the proportions should ordinarily be one part of cement, two of sand, and four of gravel; and for the abutments and wing walls, one part of cement, two and a half of sand, and five of gravel. Frequently, concrete is made by mixing cement and gravel only, but in this process there is great danger of having concrete that is very porous. The theory of concrete is that there should be enough Portland cement to fill the voids in the sand; and enough of the resulting mortar to fill the voids in the gravel or broken stone. For this reason, the entire mixture should grade from stuff that is very fine to material that is coarse. The real strength of concrete is in the strength of the mortar which unites the stones together. Very fine gravel is objectionable, as the resulting concrete has not the strength obtained by larger stones held together with a strong mortar. Where gravel contains a large percentage of fine stuff, it is usually desirable to screen it. If the fine material removed is clean and equal to a good building sand, it may be used to form the mortar, and can then be uniformly intermixed with the coarser material. A further objection to the use of gravel without this precaution, is that the finer sand is seldom uniformly mixed, but lies in pockets, and the resulting concrete is of very uncertain composition.

Timber forms supporting the concrete should be strongly bound together, with plenty of wire. A great deal of inferior work results from neglect to use properly braced and tiled form work. This applies especially to the floor supports. In bracing the form work, which is to support the slab covering, it should be an inch or so higher in the center than at the sides, to allow for settlement.

When work has been interrupted, and is again commenced, see that the old surface is thoroughly flushed with water before new concrete is deposited. The joint should be commenced with a cement grout of one-to-one mortar over the old work; or it is a successful practice when the old surface is wet, to sift over it a light coating of Portland cement. All concrete should be deposited in the forms and worked to place as quickly as possible after being mixed. As a rule, thirty minutes is the greatest period that should elapse. Any setting that has taken place and is broken in the further manipulation of the concrete, is destroyed and is finally lost to the work. For this reason, good concrete that has been put in place should not be disturbed until it has thoroughly hardened and set. All concrete, when it has been put in place, should be quickly rammed and worked in layers, so as to make the concrete perfectly compact and free from spaces and air bubbles.

As soon as the concrete slab of coarse stuff has been put in place, it should be coated over with a one-half inch covering of cement mortar, made in the proportion of one part of cement to one part of sand. This should be higher at the center than at the ends of the culvert, in order that drainage may be perfect. Concrete is porous, and unless coated with a waterproof covering, is certain to be greatly injured by moisture dripping through it.

In order that concrete will not adhere to the forms, they should be coated with oil before the concrete is put in place. A combination of crude oil and kerosene applied with a brush gives good results, but an excess should not be used. For all exposed faces of the concrete, dressed lumber should be used, and it should be cleaned and re-coated with oil at each setting.

Every care should be taken to see that the inside of the forms is free from shavings, sawdust, blocks of wood, or other debris, before putting in the concrete. A warning of this kind would seem almost superfluous, but there is evidence of no more common neglect than this. Time and again, in important work, the writer has found blocks of wood projecting from the concrete. Spacing pieces also should be removed. Neglect to do so is merely evidence that the workmen are anxious to get rid of their job in the easiest possible way, regardless of consequences.

The reinforcement shown in the flooring of this culvert should be of round steel rods. There is a common impression that any kind of iron will do, but this is an error. The steel is used to give tensile strength where tension of the concrete is likely to occur. Concrete is strong in compression, but is weak in tension. Wherever it is the tendency of loads passing over a culvert to bend a slab, tension takes place on one half, and compression on the other. The steel should be