BRIDGE CONSTRUCTION WITH TIMBER, CONCRETE AND STONE UNDER PRESENT CONDITIONS*

By O. L. Grover

IN many communities culverts and bridges must be built, even under war conditions, to keep the highways in shape for use, even where no new road construction is under way or would be authorized.

Steel has been the favorite bridge material for several years. It has been used for small as well as large structures. At present steel is not available in any quantity for bridge construction. It cannot be had at all where its use can be avoided, while all large steel construction necessarily must be abandoned or postponed until peace and normal conditions return. This situation forces the use of other material—timber, concrete, stone, and brick.

For long bridges and for temporary work where the cost must be kept down regardless of high maintenance expenses, timber is the material which must be used for superstructures. In small, permanent structures concrete, stone and brick are excellent materials, preferably in the order named. The character of the structure should be governed by the material most readily obtained, though in some instances the available labor may be the determining factor.

Culverts of Rubble Masonry

Small structures, built even under the present war conditions, should be constructed with a view to permanence. Culverts with small spans can be built readily without the use of steel, and of the most substantial construction.

In locations where suitable stone can be procured culverts of rubble masonry with stone covers may be constructed where the spans do not exceed 4 ft. Such culverts will prove satisfactory and will last for a long time. The construction is simple and where suitable stone is found in the neighborhood within easy hauling distance the cost should be reasonable. In the selection of the stone the most durable should be used.

The following table gives the thickness and width of cover stones for culverts of 2, 3, and 4-ft. spans:

Dimensions of Cover Stones

Span in feet.	Thickness in inches.	Width in inches.	Length in feet.
2	10	20	4
3	12	24	5
4	15	30	6

The masonry walls should be laid in cement mortar, and the stone slabs composing the cover should be laid in mortar beds and the cracks between stones filled with mortar.

Rubble stone suitable for masonry is found in many localities, where there are no stones suitable for the cover. Where this is the case the top may be made of reinforced concrete. This will require a small amount of steel reinforcement, but will permit the use of a longer span than is safe with the flat stone top.

While suitable stone for the rubble masonry is to be found in many sections throughout the country there are many places where it can not be obtained. In some localities it may be desirable to substitute plain mass concrete in place of the rubble masonry, because of the difficulty in obtaining suitable stone.

*From "Public Roads."

Where it is necessary to make longer spans the arch is the only type of permanent structure that can be built without metal. The height needed and foundation conditions are the controlling features in this construction.

The Construction of Arches

The arch span will not prove substantial without a solid foundation, either of cemented gravel, hardpan, or rock. So important is this in securing permanency that the arch should not be selected until after the most thorough examination of the location. In some streams the bed is of such a character that there will be no great difficulty in securing the proper foundation. In others all sorts of conditions may exist and make it difficult to provide one.

Where it is possible, the foundation should be on solid rock. Where this is not possible, it is often practicable to secure adequate foundations by carrying the footings deeper, by driving piles or sometimes by spreading the footing over a wider area.

The three materials most used in arch construction are concrete, stone, and brick. preferable in the order named.

It is necessary to carry the foundations well below the bed of the stream. For the smaller spans this should not be less than 1 ft. 6 in. and for the longer ones not less than 2 ft., unless they are laid on a bed of solid rock. Riprap and channel paving should be provided where it is necessary to prevent scour.

In building arches of stone or brick, the top of all masonry should be protected by copings of concrete or by copings of large, selected stone with grouted joints.

Brick Disintegrates by Freezing

In the South, where the climate is not subject to hard freezing, common hard burned brick may be used in building arches, but should not be used where good rubble stone is to be had. In the colder sections of the country brick does not give as good results, because it absorbs moisture and disintegrates by freezing.

The foundations should be carried to good firm material, and have a minimum depth delow the bed of the stream of 1½ ft. unless on solid rock. The brick should be laid in cement mortar and be covered with 1-in. of cement mortar troweled smooth.

Timber Trestles and Bridges

Timber may be used with satisfactory results for both temporary and permanent structures, and to good advantage where brick, stone, and concrete are not easily secured. There is hardly any part of the country where good timber can not be obtained, and for spanning streams of considerable size the timber trestle or bridge is the usual type of construction under emergency conditions. It is often hard to draw the line as to just what is meant by temporary and permanent structures. Roads and bridge building are determined by the expected uses, the necessity of early completion, probably most often by the available funds. At present, the labor available must also be a controlling factor. Bridges will be built to last as long as they will perform the required service, though it may be expected to replace them with better and more permanent structures when additional funds are at hand or conditions warrant.

Timber deteriorates unless protected or treated for preservation, and for that reason is recommended only for temporary structures and where other materials are not available. The ordinary life of a timber trestle or bridge can be practically doubled by a good preservative treatment, and if the structure is expected to remain in use