Home Course In Road Making

VII.—Highway Culverts and Bridges.

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CULVERTS and bridges are constructed for a twofold purpose. In the first place, they are required to provide the necessary drainage for the road and, in the second place, to furnish a suitable crossing for traffic over waterways. A large percentage of the highway culverts and bridges in this country were built of wood in the first instance, and in later years many of the smaller culverts have been rebuilt with some kind of pipe, either of terra cotta, cast iron or more recently of corrugated metal. It is impracticable in a short paper to discuss the various forms of pipe culverts. They are purchased in the open market, and the road official uses his judgment about the size of pipe that should be laid to serve the requirements of the location in question.

The following principles should, however, be borne in mind: All pipe culverts should be laid deep enough so that the pipe will not be injured by the

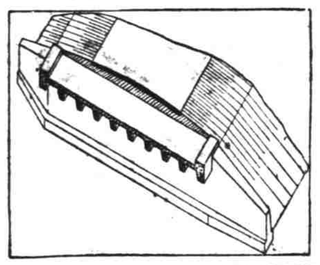

FIG. I.—CONCRETE CULVERT STEEL I BEAMS INCASED IN CONCRETE.

traffic passing over it, and head walls should in all cases be built at each end of the culverts to prevent them from being washed out. The maximum fill to be allowed over a clay pipe culvert should be at least three feet. The objection to pipe culverts is that they become easily clogged and are thus made useless. Clay pipe culverts are easily broken unless they are well laid and well protected.

The most simple and natural form of bridge consists of timbers laid across the stream or opening which is to be passed over and covered with planks to form the roadway. Walls should be built to support each end of the timbers, and these are called abutments. The width of the opening which they cross is termed the span. The timbers themselves are called stringers, and the planks are usually referred to as the flooring.

The size of the stringers required increases with the span and the distance apart, center to center, that they are laid. For example, a 2 inch by 6 inch stringer will do for a two foot span, while a 6 inch by 10 inch or 6 inch by 12 inch stringer is required for a twenty foot span. The distance apart that the stringers are required to be laid varies with the thickness of the plank flooring and the amount of traffic.

The weight of the materials in the bridge is commonly referred to as the dead load. The additional load which the bridge is designed to carry is known as the live load and consists of animals, wagons or motor vehicles or pedestrians. A crowd of people standing close together on a bridge is usually estimated at about 100 pounds per square foot of floor space.

The strength of the bridge depends upon the kind of timber used, the dimensions of the timber, the amount used and its location, and also very largely upon the span of the bridge. For example, assuming a loaded wagon carrying 500 pounds per wheel, a yellow pine board one inch thick and eight inches wide would require stringers to support it about every thirteen inches apart to carry the load safely, while a plank of the same width and two inches thick would require stringers three feet apart, and a three inch plank would require stringers about every four feet apart. These figures are based upon the assumption that yellow pine, Douglas fir or a good quality of oak would be used. If such timbers as white pine, hemlock or spruce are used, then stringers would be required about every eight inches for a one inch board, every two and one-half feet for a two inch plank and every three feet for a three inch plank.

The following table gives the approximate sizes of stringers required for the different spans.

Span in feet	Size of yellow pine stringers in inches.	Size of white pine stringers in inches.	Span in feet	Size of yellow pine stringers in inches.	Size of white pine stringers in inches.
2	2 x 6	3 x 6	9	3 x 6	4 x 8
3	2 x 6	3 x 6	10	3 x 6	6 x 10
4	2 x 6	3 x 6	12	4 x 8	6 x 10
5	3 x 6	4 x 8	14	4 x 8	6 x 10
6	3 x 6	4 x 8	16	4 x 10	6 x 12
7	3 x 6	4 x 8	18	4 x 10	6 x 12
8	3 x 6	4 x 8	20	4 x 10	6 x 12

In the above table round timbers or logs may be substituted for the stringers, in which case the diameter of the log should be about one and one-eighth times the largest dimension of the stringer as given.

Fig. 2 illustrates two methods by which the simple beam or stringer may be strengthened and states the corresponding loads that will be carried safely. That is, the simple beam 12 inches by 12 inches square and 24 feet between points of support will carry safely a concentrated load of one and one-half tons at its center, while if the same beam be made into a King post beam by passing underneath the beam a one inch steel rod, which is made fast at either end of the beam, and inserting a single post under the load at the center of the beam, then such a beam will carry about two and three-quarter times as much, or a load of three and three-quarter tons, safely, while if the same beam be built into a King truss beam the load concentrated at the center may then be increased to nine tons.

The best culverts and smaller bridges are built of re-enforced concrete. The cost is greater than for wooden or pipe constructions in the first instance, but if well built there should be no further cost for repairs. That is, the first cost is the last cost, while durability and safety are secured from the outset.

Good materials, consisting of crushed stone or gravel, sand and portland cement and water, are required for concrete. Deformed steel rods imbedded in the concrete are used for strengthening the cover spans. The mixing of these materials into concrete and placing it in the forms are extremely simple matters after they are once well understood, but nevertheless should not be undertaken by one who is unfamiliar with the use of concrete.

There are three general kinds of concrete culverts, which are known as the concrete box type. They are built for the smaller sizes up to such as have an opening about four feet by six feet wide. For sizes above that the floor is usually left out where it is not needed to protect the foundation, or paving may be substituted for it. The floor and side walls are constructed of concrete with or without metal re-enforcement, usually without such re-enforcements. The proportions of concrete used for the floor and side walls are usually, 1, 3, 6—that is, one part by measure of portland cement, three parts by measure of sand and six parts by measure of crushed stone or gravel. For spans above ten or twelve feet the cover needs to be strengthened with concrete beams. This type is known as the concrete T beam from its resemblance to the capital letter. They are placed adjacent to each other, the distance from center to center depending upon the load which the bridge is expected to carry.

The best type of concrete culverts for spans from ten feet up to thirty feet is the steel I beam incased in concrete, as shown in Fig. 1. Here the concrete floor is designed to carry the load across the span from one I beam to another, while the steel I beams carry the load from one abutment to the other. It often happens that the culverts are built on yielding foundations and that the abutments sometimes settle, causing cracks that would be dangerous in some types of culverts, but it is the ability of the steel I beam type to withstand such conditions as these just mentioned that makes it the best type to build. The I beams are incased in concrete to protect them from rusting. Sometimes they are simply painted or more often not painted at all, and what would be a permanent bridge is allowed to rust out for lack of proper care.

For details in regard to the methods of designing and building concrete bridges attention is called to bulletin No. 39, "Highway Bridges and Culverts," issued by the office of public roads, United States department of agriculture.

No road can be called a good road that is dotted with broken, wornout and unsafe wooden culverts and bridges, such as are encountered on

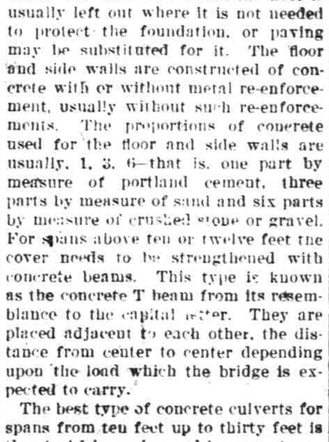

FIG. II.—COMPARATIVE TYPES AND LOADS FOR WOODEN BEAMS.

many of our highways at the present time. Such bridges are a menace to our traveling public and are expensive to maintain. The price of timber is advancing, and the increasing traffic demands safer bridges and culverts. Re-enforced concrete for this class of work appears to form the best solution of this problem. Bridge construction is eminently the work for the engineer, and his services should in all cases be secured.

The Road Contract System.

There are three systems of road maintenance in use in this country—viz, the contract system, the labor tax, or personal service system, and the system which provides men permanently employed to look after particular sections of road. The contract system has been used to some extent in various states, but it has never been found entirely satisfactory. As a general rule, the amount paid for this work is small, and such poor service is rendered that in many cases the roads have become worse rather than better.

LODGE RESOLUTION TELLS WORLD U. S. TO PROTECT APPROACHES

Measure Reported by Foreign Relations Committee Declared Not Direct Reaffirmation of Monroe Doctrine

WASHINGTON, Aug. 5. — Leading members of the foreign relations committee declared today that Senator Lodge's resolution, designed to make clear to the world this nation's position regarding eencroachment of foreign powers upon the western continent ,is not a direct reaffirmation of the Monroe doctrine but an announcement by the United States that it will protect its approaches and prevent the establishment of foreign naval or military bases at threatening points in this hemisphere.

The resolution, which was unanimously adopted by the committee and reported Wednesday, will come up today for Senate action. It affirms that the United States cannot see "without grave concern" any harbor or advantageous spot in the western hemisphere taken over by a foreign government, or by a foreign corporation bearing close relation to the government, if such occupancy would threaten the commerce or the safety of the United States.

It is the outgrowth of the activity of an American syndicate which sought to sell to a Japanese fishing corporation 4,000,000 acres of land about Magdalena bay, in southern California.

Though the foreign relations committee, upon investigation of the Magdalena bay project, found that the Japanese government had no connection with it, they determined that the Senate should assert its belief that foreign corporations should not be allowed to secure sites in the western hemisphere that might later be turned over to their home government for naval or military bases.

The resolution was strengthened before submission to the Senate Wednesday by an amendment by Senator Hitchcock. Not only does it declare against the possession of these "advantageous points" by corporations wholly foreign, but it covers also American corporations, the control of whose stock may have passed into foreign hands.

RAILROADS PLACING ORDERS FOR LARGE AMOUNT EQUIPMENT

PHILADELPHIA, Aug. 5.—On the eve of what manufacturers and business men generally believe to be one of the biggest industrial revivals ever experienced in the history of the country, the railroads are in the market for a larger amount of equipment than at anytime in the last five years, says the North American. By the fall it is generally predicted that the railroads of the country will have in operation a greater complement of motive power and rolling stock than they have ever had in their history.

In the six years between the end of 1905, considered a banner year in freight movements, and the beginning of this year, the average annual output of locomotives for the various railroads aggregated 3378, while the car output averaged 107,630.

In the first six months of this year the orders placed have already aggregated 2100 locomotives and 102,000 freight cars, which is equivalent to 4200 locomotives and 204,000 freight cars for the year.

These totals have never before been equaled in the history of railroading, and the general feeling is that the railroad officers have taken extra precautions this year to see to it that there shall be no congestion when the crops begin to move.

One of the largest orders to be placed was the contract awarded recently by the Boston & Albany railroad through the New York Central lines which will involve an expenditure of approximately $5,000,000.

Nearly 10,000 grain cars are being built by roads having headquarters and terminals in Minneapolis and St. Paul, according to officers of the roads who declared that the cars would be rushed to gain producing points in order that there may beno dearth of rolling stock. Every one of the new cars will have been distributed throughout the Northwest by Sept. 1.

An unusually marked improvement has been noted in the Iron and steel market in the last few weeks and several mills in western Pennsylvania, which made additions to their plants a few years ago to take care of increased business, are planning more extensive additions so as to properly hands the large trade they expect in the next few months.

Figg—Don't you wish you could live your life over again?

Fogg—Well, I should say not! I've got a 20-year endowment policy maturing this month.