and, consequently, beauty of appearance is not given full value in deciding on the type of structure. It is a question as to how much additional money should be spent in order to achieve a pleasing appearance. The cost of a bridge is, however, soon forgotten, but an unsightly bridge cannot be forgotten, for it remains as a constant unpleasant jar on the senses.

Determining True Economical Type

In selecting the most economical type of bridge, first-cost, upkeep and value of non-interruption of traffic must be considered. The timber structure is in about every case the cheapest in first cost, but in the long run it does not generally prove to be as cheap as steel or concrete. A wooden pile bridge, if suitable for the site, is no doubt the cheapest bridge in direct cost. For example, a 50-ft. pile bridge will cost to-day about $1,500. Allowing 6% interest, a yearly payment of $270 would be required to keep this bridge in condition, made up as follows: Flooring to be renewed every three years, first cost $270, yearly payment for three years $101; stringers to be renewed every six years, first cost $270, yearly payment $55; remainder of bridge to last twelve years, first cost $960, yearly payment $114; total yearly cost $270. Indirect costs, such as delay to traffic during repairs, loss of traffic through neglect of repairs, liability to accident or fire may run the total cost far beyond the direct costs. At best, the pile bridge is very unsightly and only to be considered where first costs are of prime importance, as they sometimes are.

Comparison of Timber, Steel and Concrete

In many cases stream conditions are such that it is not permissible to have piles in the stream bed and a clear opening of long span is required. The type of structure may then be a choice between a wooden span, a steel span or a concrete span. Unless the wooden span is to be placed on piles, which, in many cases, is not feasible, the cost of the substructure for the three types will be about the same, so that it will only be necessary to compare the relative costs of the superstructure. Again selecting a 50-ft. span for comparison, and assuming wooden flooring to be renewed every three years, wooden stringers to be renewed every six years, painting wood and steel to be carried out every four years, the life of concrete and steel to be over 30 years and the life of a wooden truss to be 15 years, we have the following relative costs:—

First Costs

Wooden Truss—	
12,400 ft. b.m. timber at $100 per M.	$1,240
3,000 lb. steel at 15c. per lb.	450
Painting	250
	$1,940
Steel Bridge—	
17.6 tons steel at $220	$2,772
4,600 ft. b.m. timber at $80	368
	$3,140
Concrete Bowstring—	
68 cu. yd. concrete at 35c. per cu. yd.	$2,380
11,600 lb. steel at 10c. per lb.	1,160
1,850 sq. ft. mesh at 20c. per sq. ft.	370
1,000 lb. structural steel (bearings, etc.), 20c. per lb.	200
Crosby clips and handrail	200
	$4,310

Yearly Costs

Wooden Truss—	
Flooring, 2,800 ft. b.m. at $80, cost $224, yearly payment based on three-year life	$ 84
Stringers, 3,200 ft. b.m. at $80, cost $256, yearly payment based on six-year life	54
Remainder of bridge $1,210, yearly payment based on fifteen-year life	125
Yearly cost of painting every four years	72
Total yearly cost	$ 335
Steel Truss—	
Timber, 4,670 ft. b.m. at $80, cost $374, yearly payment based on three-year life	$ 140
Yearly payment on steel truss for 30 years (cost $2,772)	201
Yearly cost of painting every four years	36
Total	$ 377
Concrete Bridge—	
Yearly payment on concrete bridge for 30 years (cost $4,310)	$ 311

It thus appears that the concrete superstructure, for spans of this length at least, is cheaper than either wood or steel. It must also be noted, in the case of steel and concrete bridges, that at the end of thirty years the bridge is paid for and the yearly payments cease (except for the repairs on the steel bridge), while in the case of the wooden bridge the yearly payments still go on.

Each Bridge a Special Problem

For bridges of any size it is impossible to make any general statement that one class of bridge is cheaper than another, as every bridge is a problem in itself, and the foregoing is given as an example of a method of obtaining relative costs. The question of the nature of the foundations, cross-section of the stream-bed, condition of stream flow, waterway required, availability of materials, relative cost of materials, relative costs and availability of labor, relative cost of substructure to the superstructure, ice conditions and economical and suitable length of span must be taken into account when deciding which is the economical bridge. Wooden bridges are confined chiefly to two types, the pile trestle and the Howe truss. For steel bridges of clear span of 30 ft. or under, simple stringer spans are cheapest; from 30 ft. to about 45 or 50 ft., plate girders; from 50 ft. to 80 or 90 ft., low or pony trusses; 400 or 500 ft., trusses with subdivided panels; beyond this, cantilever or suspension bridges, with steel arches, coming in any place in the list.

Every concrete bridge is a study in itself. In Manitoba there have been constructed, or are under way, slab and girder bridges up to 30-ft. span, through griders up to 50-ft. span, barrel arches up to 100-ft. span, open-spandrel arches up to 60-ft. span, through arch or rainbow type up to 90-ft. span and bowstrings up to 90-ft. span. These are, however, only given as an example of different types of concrete bridges.

In appearance the concrete bridge can be made to surpass any other kind of bridge. It can be poured into any form, and beauty must lie in its lines and not in any ornamentation. It offers an opportunity for its designer to give to his country a structure that will be a constant pleasure to beholders, and which will be in mind long after the cost is forgotten. There is still another strong argument for the use of concrete, and it is that the materials used in the making of concrete are almost without limit. The time when our timber will be exhausted can be foreseen. Iron ore is limited and can never be replaced.

Types and Relative Costs of Culverts

Coming to the small but important culverts, there are, in general, four types in common use: First, wooden culverts; second, steel or iron culverts; third, concrete pipes; and fourth, concrete culverts cast in place. The wooden culvert is undoubtedly the cheapest, but the objection to this is that it is out of commission or unsafe about 101% of the time. In point of cost, concrete pipe culverts come next. These, however, must be placed where no water will freeze in or around them, and they must have a good, solid bed. Considerable saving has been effected in Manitoba by the use of concrete pipe, and the results have been quite satisfactory. The cost of manufacture last year ran about as follows:—

10-in. diameter	36 cents per lin. ft.
12-in. "	45 " " "
15-in. "	50 " " "
18-in. "	83 " " "
24-in. "	$1.22 per lin. ft.
30-in. "	1.75 per lin. ft.

The breakage in handling ran about 1%.