# The Callender-Hamilton Bridging System*

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**A non-floating military bridge designed by a New Zealand engineer for heavy traffic use in rear areas where ultra-rapid erection was not the first essential. Widely used in all theatres or war—though not so publicized as the Bailey bridge—the Callender-Hamilton bridge has many civil applications.**

### History.

THE idea for this bridging system came about in the following way. The writer was, during 1928 to 1932, engineer-in-charge of the Rowanduz Road construction which involved some unusually difficult bridging over canyons and rivers in very inaccessible country in the Zagros Mountains, which here fringe Northern Iraq.†

Owing to the scarcity of timber, steel bridging gave the only possible answer to the problems involved, and it so happened that various types of bridges had to be employed. In Iraq there were stocks of nearly all the types of steel military bridges used in the last war, and these and some others specially designed for certain crossings were sent up to the road head. The specially designed bridges were, of course, manufactured in England. After completion they had to be transported by sea and then 600 miles overland, partly by rail and partly by road from the nearest port which was Basrah, so the delay in obtaining them was naturally very considerable. Moreover, the difficulty of knowing the correct spans to order, with but little knowledge of the flood levels of the rivers, added still another factor to the problem of supply.

In these circumstances there was for the writer an excellent opportunity to study the whole problem facing the colonial bridge engineer. If this problem could be solved in some realistic and entirely new way, the same means should be of help to bridge engineers generally. So having transported, assembled and erected a considerable number of these older types of bridges, with no help other than unskilled tribal labour, and while still completing the rather formidable road excavation, the writer in 1930, in collaboration with Mr. G. D. White-Parsons, sketched out a new type of bridge that would best meet his requirements of speed and simplicity, and planned the founding of a world-wide service for bridge engineers and roadway and railway constructors.

### The Project.

As far as was known, no proposal of the same kind had been made before in any country.

The plan envisaged was none other than to make a radical change in bridging methods by the provision of ready-made bridge stocks which would be so adaptable to any bridging problem that the crossing of a stream, river or obstacle, anywhere, would be capable of immediate accomplishment in a quick, yet permanent and economical manner. The same set of bridge parts, for example, would be capable of serving equally well for a pack bridge in the Assam jungle or for carrying buses on a London street, services which, in fact, they perform today.

In all cases such bridges should be as durable as possible, and not unpleasing in appearance. Advice about such matters as assembly and erection, and the launching of the bridges over any conceivable sort of gap, would be given as a service. As much of the bridging as urgent calls might require would need to be stocked.

This was, in essence, the project. How well it was to be realized could hardly have been believed at that time.

### Novelty.

The structural principles underlying all types of steel bridge trusses and girders have long been well understood. This makes it difficult to introduce any real novelty into bridge design. It may generally be said that apart from using more expensive steels or new light alloys, weights and costs of similar well-designed bridges should be of a like order, and the minimum overall cost is usually obtained from the simplest construction. So, basing plans on what could be most easily made, the writer drew up his specification for the new bridging materials somewhat as follows:—

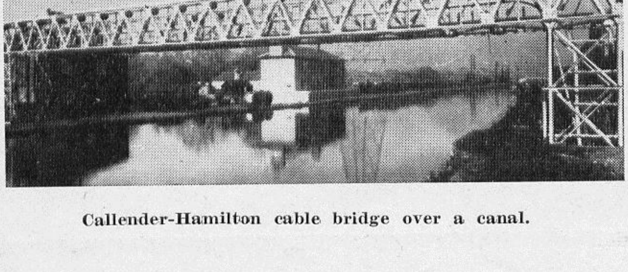
1. The steel sections should be those obtainable from any steel mill. Fabrication of the steel into bridge parts should be possible in any ordinary workshop. If high-tensile or special weld-quality steels are available so much the better, but they are not vital. Thus manufacture can be conducted almost anywhere and local industry can benefit.

2. The parts of the bridges should be as light as possible to permit easy handling by one or two men (in railway bridges the parts are naturally somewhat heavier). Thus large gangs, except perhaps for greater speed, are not needed during transportation or erection. The parts should, of course, be easily assembled by any ordinary workman.

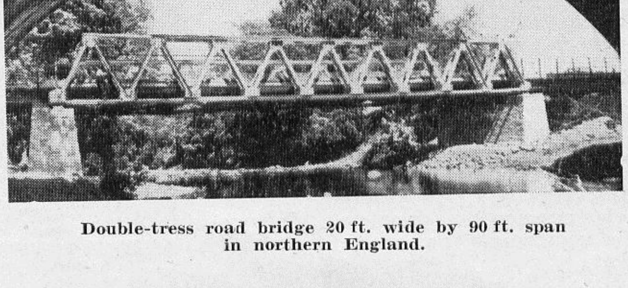
3. The final bridge when in place should be at least as strong, and yet as light and as economical as a specially designed bridge, whatever the span. This was the really difficult condition to fulfil. Under the new system, however, a patented feature was introduced whereby the strength of the bridge members is readily proportioned to the load they have to carry. This innovation for standardized bridges enables not only a bridge of one degree of strength to be provided for a given span length, but a reasonably economical bridge to any loading specification, whether light or heavy, and whether British standard or any other. Further, by stepping up the depth of spans as the length of bridge increased, a very much wider range of bridge lengths was secured than anything previously

*By courtesy of the British Council.

†Described in the writer's book "Road Through Kurdistan"—(Faber & Faber).



Callender-Hamilton cable bridge over a canal.



Double-tress road bridge 20 ft. wide by 90 ft. span in northern England.

contemplated. In respect of economy and range this bridging system has never been equalled.

4. The individual bridges should be capable of fast assembly and erection. For specially rapid erection such as military conditions might impose, standardized panels are not excluded and may be pre-assembled. Still other variations may be readily employed where speed is an over-riding consideration.

5. The parts should be adapted for forming into through or deck type bridges, and serve also as steel piers, columns and bridge substructures—uses they fulfil today.

6. As a test of the overall economy, the total number of man-hours required for fabrication and erection and maintenance should be equal to or less than that of any other type. This is regarded as an important criterion. It is interesting that after the design was made, Callender's Cable & Construction Co. found the unit parts to be very suitable for galvanizing in accordance with transmission tower practice, and as the bridges are therefore generally supplied fully galvanized, even to bolts and end bearings, they need little or no further attention, whether in storage or in actual service. Thus painting may be dispensed with and much labour of maintenance is saved.

### Design Aspects.

Close attention has been paid to the structural design. Both by calculation and actual tests of the unit parts and the made-up bridges the strengths of all spans and their factors of safety are accurately known. Moreover the values of the individual members according to the various standard bridge-stress specifications are known and listed, so that designs for new conditions are very quickly determined.

It is the writer's practice to make up models, exactly to scale, of each of the new types of bridges; and in some cases to test these models. Moreover the full scale bridges have also been tested under heavy and varied forms of loading by several authorities, particularly for impact effects of all possible sorts, so that a valuable fund of information has been gathered. The writer must express here his indebtedness to several eminent engineers who have assisted with the development.

To obtain the most economical bridges on exactly the same general system suitable for such light duty as footbridges and such heavy duty as railway bridges, the principle of "similarity of structures" has been used, whereby proportions of all truss members are largely kept the same but the scale size is changed as a whole. Thus the steel weight in a small footbridge may be only half a ton and the weight of a railway bridge 300 tons, but each would be of the same order of high efficiency for its duty.

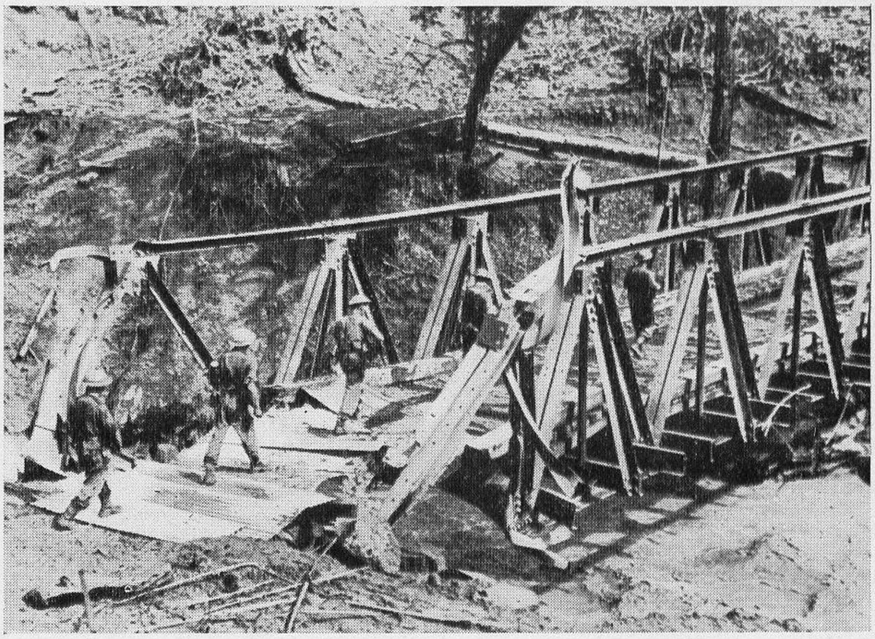
### Present Position.

During its first ten years of effective life this bridging system has already fulfilled a wide range of uses, in Britain and throughout the world, for both civil and military purposes, while the number of different users who have adopted the system has steadily increased. Typical instances of service in the British Isles include cable bridges, factory bridges of many different sorts, footbridges over main traffic arteries and highway bridges placed where there has been bomb damage to viaducts or where older bridges have been unable to carry modern traffic. In what might have been one of the most serious episodes of the air "blitz" the standardized trusses replaced at short notice a bridge carrying a vital 8 ft.-diameter sewage main in a densely inhabited quarter.

In cities and on main road arteries of the country they have been carrying for some years a significant part of Britain's heaviest war traffic. Even 150-ton vehicles have gone safely over them. In army use they take the heaviest tanks with ease.

In particular, the bridging system was the standard one held in reserve to replace, as needed, all the major bridges of the United Kingdom, should any of them be destroyed or seriously damaged by the enemy. Single and double track spans up to 200 ft. were ready in every detail throughout the war, and all the leading bridge contracting firms had staff trained to use them.

The ease with which the bridges can be fabricated has made them suitable for production throughout the Commonwealth, and large numbers have been made and put into use. Overseas armies have used them in nearly all the war theatres since the earliest campaigns, and their toughness after attempted enemy demolition is well illustrated by the illustration of a bridge on the Burma frontier, still standing after severe damage.



**Single-tress army-type road bridge 12 ft. wide by 80 ft. span, damaged but not destroyed by the Japanese. Such bridges were widely used in this theatre of war.**

There are probably more highway bridges in service than railway bridges, but the latter have been just as important in the war, and their remarkable story has yet to be told. One such railway bridge of 250 ft. span was done very expeditiously without staging or falsework, over a river in flood.

### Future Possibilities.

The system has already justified all the hopes the writer had for it after so short a period. Yet its full impact as a world wide bridging service is likely to come not during war when so much bridge work is strictly controlled and steel supply is so limited, but rather in the days of peace and reconstruction when the economics of bridge-building again receive full attention, and great new schemes for land communications are put in hand. The writer believes that every country will eventually make wide use of this British development.

## AUTOMOTIVE ENGINEERS

Membership in the Automotive and Aeronautical Engineers' Institution is now 281, having doubled in the last two years, says its annual report. Groups are actively operating at Auckland, Wellington, Christchurch, Burnham Camp, Dunedin, and Invercargill.

Though world affairs are not settled, and indications are that the effects of the war will be felt for a long time yet, there is no question that the research will in due course be made available to commercial enterprise, said Mr. J. L. Broun, at its annual meeting.

Probably no branch of engineering will benefit more this way than the automotive side, said Mr. Broun.