

in this respect is noted in the Cambridge bridge case summarized later.

Increase in Cost.—The best plan to pursue in determining the difference in cost of bridges with and without street cars seems to the writer to be that of comparing two designs, one the detailed design of the structure, the other a stress sheet design with the cross-sections of all members carefully determined. The two designs should be similar in type. Allowance for the weight of the details of the second structure may be made by considering the details of each individual member to vary in weight in proportion to the variation in the cross-section of the main member, this relation being obtained from the detailed design of the first case, or if the structure has been completed, from the gross shipping weights reduced by the computed weight of the main sections. The same unit prices should be used in both computations.

In the case of a reinforced concrete barrel arch bridge, it would seem as if the additional cost would ordinarily be dependent entirely upon the increased width, since for such a bridge the effect of the concentrated wheel loads would be largely distributed by the dirt fill. For such a bridge it might be possible to estimate the increased cost by determining the cost of a strip of the bridge, using for this purpose the same unit prices as for the remainder of the bridge.

The question has arisen in some cases with which the writer has been connected, as to whether the cost of engineering, insurance, etc., should be assumed to vary directly with the cost of construction. This is perhaps open to legitimate discussion. It would seem to the writer as if these items should vary directly with an increase in width, since such increase would certainly involve additional engineering and inspection, and would prolong the time of construction. Whether the increase should vary directly with an increase in strength is not quite so obvious. Little additional engineering cost is required to provide for heavier sections in floor beams, stringers and trusses. On the other hand, it is probable that no better unit actually exists for determining the difference in these items than the total cost of the completed structure, and it would seem as if it would usually be proper to adopt this basis for determining additional charges for engineering, etc. In the cases of the Chelsea and Meridian Street bridges the percentage charged for these items was the same for bridges both with and without street cars, and this was agreed upon by the railways as a proper charge before the case came up for hearing.

Convenience.—In determining the proportion which a street railway should pay towards the cost of a given bridge, the question of greater convenience to the railway is one which deserves careful consideration. The advantage to the railway company of having a new bridge of ample size and strength to allow for unrestricted traffic running at a reasonable speed, and to provide for any probable increase in weight of rolling stock is a factor which may possibly result in economy of operation far in excess of the actual expenditure necessary to provide for increased width and strength. In the case of a new bridge providing an opportunity for a contemplated new line of railway traffic, it is quite conceivable that the railway might afford to pay a very considerable proportion of the cost. In fact, if the line is to be built, at all events it would seem as if the railway company could afford to pay towards the construction of the bridge an amount equal to the cost of a new structure plus the capitalized cost of maintenance less salvage, provided the bridge is to be owned and maintained by the municipality and equitable

arrangements are made for reimbursing the railway if its franchise is taken away by no fault of its own.

That street railways have often agreed in advance of construction to pay a very considerable proportion of the cost of the bridge in some cases, is doubtless due to reasons such as this. Similar instances of great and immediate convenience to street railways, due to the reconstruction of an existing bridge, may readily occur. Such, for example, was the condition in the case of the Meridian Street bridge. In this bridge some of the timbers of the existing structure had actually begun to crush under the heavy cars operated by the railway, and for some time prior to the reconstruction, car traffic was not allowed across the draw-span, passengers being required to change cars and walk across the draw. This naturally imposed an undue inconvenience upon passengers and an extra expense upon the railway. In such a case it would seem quite clear that the railway might well pay toward the reconstruction of the bridge an amount in excess of the additional cost of the structure to provide for their loads. Another factor under this heading might well arise in the case of a draw-span over a stream with much traffic. The increased rapidity of operation which might conceivably occur with a new bridge would certainly be of value to the street railway in preventing traffic interruption.

Decreased Cost to Street Railway of Maintenance and Operation.—The fact that the cost of maintenance and operation of a highway bridge would ordinarily be borne by the municipality should be considered in apportioning the cost to the street railway. This would be particularly pertinent in the case of swing bridges, where it would seem as if a fair arrangement would be for the railway company to furnish the current necessary to open and close the bridge, and for the municipality to maintain the draw-tenders and other attendants. In general, it would appear that the street railway company might reasonably be charged as its portion of the capitalized cost of maintenance, a share proportionate to its contribution to the cost of construction.

Franchise Taxes and General Taxation.—All of the above discussion should be considered with due regard to the fact that the railway company is ordinarily subject to heavy taxes, and in consequence, should be entitled to operate across the bridge with vehicles of weight equal to that of the heaviest motor trucks. The only equity in charging the railway more than the ordinary transportation company is because of the heavy loads which it operates.

Conclusions.—The conclusions which the writer has drawn from his experience in apportionment cases of this character are as follows:—

(a) Additional width to provide for street cars is ordinarily necessary only in the case of bridges with narrow roadways, providing for no more than two lines of traffic.

(b) The extra expense involved in strengthening heavy city bridges of permanent type to provide for 50-ton trolley cars would not ordinarily be greater than 10% of the total cost, and may be as low as 6%. This percentage will be greater for light country highway bridges without paved floors, but if such bridges are designed for heavy motor truck traffic, as they should be, the additional expense will not be excessive.

(c) To apportion the cost equitably, and with credit to the engineering profession, the engineers on the two sides should try to agree upon the additional cost of provisions for street cars before the case is presented to an