beams only, the result being in effect that of providing a separate street railway bridge and thereby preventing vertical vibration due to the street cars from being felt on the sidewalks, which continued to be supported by the original trusses.

While street railways have been compelled either to strengthen existing bridges at their own expense or to forego the economies to be gained by operating heavy cars across them, no such compulsion has existed in the case of new bridges and it might seem as if the railways should be relieved from contributing toward their expense. Certainly the claim of the railways that the bridge is but a part of the highway on which they have the same right as others, and for the maintenance of which they pay a reasonable share in the form of taxes, is a legitimate one, and should be given due consideration. The fact, however, that trolley cars are so much heavier than other road vehicles, puts the companies under different obligations than other users of the bridges and makes it seem fair to assess upon them the extra expense required to provide for traffic of this character. This has been recognized by the Massachusetts Legislature, which has adopted in recent years the practice of providing for such assessments either by direct assessment, in advance of construction, of the amount to be charged to the railway, or by providing for its determination by a commission sitting after the bridge has been completed and the actual cost is known.

The assessment by statute of street railways to pay for the cost of new bridges has varied in Massachusetts from a minimum of 10 per cent. to a maximum of 25 per cent., the variation being probably due to the intensity of the desire of the street railway to operate heavier cars or to obtain new locations and to the arguments put before the Legislature by the interested parties. Such a method of determining the proportionate share to the railway may be reasonable in many cases, particularly if the total cost involved is comparatively small, and furnishes an excellent solution if each party agrees in advance upon its share.

The acts and resolves of the Massachusetts Legislature relating to grade crossing abolition specify in the case of the elimination of a crossing involving a street railway that the latter may be assessed an amount not exceeding 15 per cent. of the total cost.

In contrast to the method of determining by legislative enactment the share which the street railway shall pay toward the cost of new highway bridges over which it may wish to operate its cars, may be placed the method which has been adopted in the case of several large bridges in Massachusetts and vicinity, of determining the cost by hearings before a commission appointed by the court to decide upon the just and equitable charge to the street railway company. In cases of this sort, the engineer's services as an expert witness are needed, and the primary purpose of this paper is to present the questions at issue, to consider these questions and to present the decisions reached in certain of such cases. In order to set forth clearly points which may arise in such an investigation, the following list is given in which the writer has attempted to include all the elements entering into the problem which may influence the decision.

1. Type of Structure—(a) Temporary bridge; (b) ordinary permanent structure; (c) monumental structure.

2. Additional Dimensions Due to Street Railway—(a) Width; (b) length.

3. Additional Strength Due to Street Railway—(a) Superstructure; (b) foundations; (c) impact and future increase in loads.

4. Additional Cost Due to Street Railway—(a) Variation with increased width; (b) variation with increased strength.

5. Additional Convenience to Street Railway—(a) Increased speed of operation of railway.

6. Decreased Cost to Street Railway of Maintenance and Operation.

Type of Structure.—(a) and (b) Temporary vs. Permanent Bridge. The dead weight of a temporary bridge would ordinarily be much less than that of a permanent structure built to carry the same loads. It may be designed with higher unit stresses; permanent paving can be omitted, and piers and abutments may consist of pile trestles. Its width need be only sufficient for the immediate needs of traffic, and in case other bridges exist within a reasonable distance, very heavy drays and trucks may be prohibited from using it. The influence of heavy street car loads on the cost of such a bridge is evidently much greater in proportion than would be the case on a more permanent bridge, with its heavier dead load.

(c) Monumental Structure. If the structure is to be of a monumental type with towers, carving and other ornamental features, it would seem at first thought as if no part of such ornamental work could be legitimately charged to the railway. Further consideration, however, shows that the scale of the towers, carving and other ornamental features may be a function of the width of the bridge, and if increased width is necessary to provide for street car traffic, additional expense for this purpose may legitimately be incurred.

Additional Dimensions .- Whether any material increase in width to provide for street car traffic is necessary, depends upon the density of the traffic. If the street car service is infrequent, there would seem to be no reason for increasing the width of the bridge to provide for street cars other than by the slight amount necessary to provide safe clearance for crowded street cars. Ordinary traffic can readily run on the portion of the bridge occupied by the track with little or no delay, and space for extra lines of traffic need not be provided. An example illustrating such a case is the Meridian Street bridge of Boston. The apportionment of the cost of this bridge to the street railway was referred to a commission. Before the case came to a hearing, however, it was agreed upon both by the city of Boston, which the writer represented, and by the Boston Elevated Railway Company, that the proper distance centre to centre of trusses might be two feet six inches less for a bridge without street cars than for the bridge actually constructed which provided for two lines of street cars.

Another example illustrating the same case is the Chelsea North Bridge of Boston. Provision for four lines of traffic was evidently necessary on this bridge, but it was agreed by both sides before presentation to the Apportionment Commission, that a roadway forty feet wide between curbs, with trusses forty-four feet centre to centre, was required whether street cars were or were not to be operated, this space providing for four traffic lines. In consequence, no charge was made to the railroad for additional width.

In the case of the Cambridge bridge, a monumental structure providing not only for ordinary street car traffic including surface cars, but also for a double-track rapid transit line, a reservation was made along the centre of the bridge to be used exclusively for rapid transit trains. It is quite evident that in this case a marked increase in the width of the bridge was due to the provision for the rapid transit railway. The actual width required for this