purpose, however, was not agreed upon prior to the hearing before the Apportionment Commission, and the railroad argued successfully that while the space out to out of curbs protecting their tracks amounting to twenty-seven feet might be a legitimate increase in the width of the bridge, they should not be charged for the entire space occupied by the curbs, particularly as one curb might have been omitted by placing their reservation to one side instead of in the centre of the structure.

In order to determine the proper width of a bridge with or without street car traffic, the following statistics concerning widths of vehicles may prove useful.

Street Cars.—Ordinary street cars operated in Boston are eight feet wide. The extreme width of the widest car is 8.79 feet. The distance between centres of tracks as specified by the Massachusetts Public Service Commission is 9.71 feet. The clear width required by two lines of the widest cars is, therefore, 8.79 + 9.71 = 18.5 feet.

Horse-drawn Vehicles.—The width of such vehicles as measured in the streets of Boston is given in the following table in which (a) = distance out to out of hubs; (b) = distance out to out of wheels; (c) = distance out to out of whiffletrees.

	(a)	(b)	(c)
Hay wagon	7.75	7.00	8.00
Heavy express	7.65	6.70	7.90
Heavy express	7.80	6.70	7.60
Ice wagon	7.40	6.60	7.00
Hack	6.08	5.25	6.83
Coal wagon (3 horse)	8.50	...	10.83

Motor cars.—Maximum width now in use, 10 feet.

In order to accurately measure the capacity of a bridge or street in relation to traffic, it is evidently necessary to consider the character of the vehicles and their speed as well as their number. For the purposes of making such a comparison, the London Board of Trade sets up as a unit a motor cab or carriage, and assigns the following numbers to other classes of vehicles.

Trade vehicles.		Passenger vehicles.	
1 Horse (fast)	3	Electric trams	10
1 Horse (slow)	7	Omnibuses (horse)	5
2 Horse (fast)	4	Omnibuses (motor)	3
2 Horse (slow)	10	Cabs (horse)	2
Motor (fast)	2	Cabs (motor)	1
Motor (slow)	5	Carriages (horse)	2
		Carriages (motor)	1
		Barrows	6
		Cycles	½

The Board lays down the following definitions:—

"Traffic Volume" at a point is the average aggregate number of traffic units attributable to vehicles which pass it per minute during the twelve hours from 8 a.m. to 8 p.m.

"Average Traffic Density" is the aggregate number of traffic units attributable to vehicles which pass the point during the twelve hours, per minute, per ten feet of available carriageway.

"Greatest Traffic Density" is the average density per minute, per ten feet of available carriageway, during the busiest hour, expressed in traffic units.

With the above units and definitions in mind, the following comparison of traffic on London bridges is clear:—

	Westminster Bridge	Waterloo Bridge	Southwark Bridge	Blackfriar's Bridge	London Bridge	Tower Bridge
Traffic volume	91.4	60.5	105.9	16.6	89.2	84.7
Average traffic density	20.3	22.0	14.4	5.8	24.1	24.2
Hour of greatest density	6-7	5-6	6-7	...	11-12	11-12
Density of that hour	23.8	22.5	15.3	...	27.4	27.9
Average vehicles	4.2	3.9	5.0	4.1	4.0	6.0

In connection with the width of bridges it should be remembered that the capacity of a bridge in vehicles per hour is considerably greater than that of the ordinary city street due to the freedom from interruption by traffic on intersecting streets and by vehicles stopping at the curb to discharge and receive freight or passengers. It is evident that the width of bridges on curves may have to be increased greatly to provide proper clearance for street cars.

It is seldom that the length of a bridge is a function of the street railway. Such a condition may, however, occur in the case of a bridge on a curve where the curve must be made flatter than would otherwise be necessary in order to provide proper clearance. The writer is familiar with two bridges where this has occurred. One of these is the temporary Chelsea North bridge, Boston.

Additional Strength.—The additional strength required to provide for street car traffic depends primarily upon the differences in weight and allowances for impact between ordinary vehicles and street cars. The specifications of the Massachusetts Public Service Commission require that all bridges in the state carrying street railways are to be designed for electric cars weighing fifty tons, and recommend that the following concentrated loads shall be assumed on the highway in addition to the uniform live load:—

(*a*) City bridges, carrying heavy loads, 20 tons on two axles, 12 feet apart.

(*b*) Suburban or town bridges, 12 tons on two axles, 8 feet apart.

(*c*) Light country highway bridges, 15-ton road rollers, with three wheels, or rollers—the weight on the 4-ft. wide front roller to be 6 tons, and on each 20-inch wide rear roller to be 4½ tons.

These specifications are under revision and the writer is informed by Mr. Lewis E. Moore, member of the Western Society of Engineers, and engineer of bridges and signals for the Public Service Commission of Massachusetts, that the following loadings will hereafter be specified. Two 50-ton trolley cars, with trucks 20 feet centre to centre, wheels 5 feet centre to centre, with impact varying from 25% to 10%, depending upon the loaded length required to give maximum stress; if the road wishes to operate standard freight cars, above weights to be increased 50%. One 20-ton motor truck, occupying a space 10 feet wide, 32 feet in length; axle loads 14 tons and 6 tons, respectively; axles 12 feet centre to centre; impact 50% on steel stringers, floor beams and hangers. Uniform live load is to be used with these loadings.

The increase in strength necessary to provide for street cars is most marked in the floor systems. It is less noticeable in trusses and girders, and least of all in foundations. In the case of foundations, the additional strength (size) depends largely upon the character of the bridge. In the case of heavy city bridges with paved floors, where no increased width is necessary to provide for street car traffic, the difference between the live loading of the street cars and that due to ordinary roadway traffic would not materially affect the foundations.

The allowance for impact and future increase of street car loads must be carefully considered in determining the additional strength of the structure. So far as the foundations are concerned, it is doubtful if any allowance for impact need be made.

The question of future increase in loading due to the street railway is a difficult one to satisfactorily adjust. An interesting example of a somewhat unexpected increase