cepted as 14 feet. This height is also sufficient to clear regular street railway traffic. While higher objects are moved along roads (streets or highways) occasionally it is properly not considered necessary to endanger the practicability of crossings under railways to accommodate them. With the railway on moderate embankment undercrossings of roads, subways, as they are called, become readily practicable. In many cases it is possible to sufficiently change the grade both of railway and road to meet requirements for a subway. Sometimes a deviation of the road, or change of location for a short distance, is practicable, and greatly simplifies the desired grade separation.

The vertical clearance, top of rail to bridge, called for over railway tracks is in most cases much higher than over roads, and this constitutes, in the great majority of cases, the insurmountable obstacle to grade separation. The highest fixed projection on an ordinary railway train is the locomotive smoke stack, and passenger cars project higher than the great bulk of freight cars; but some, comparatively few, extremely few, special freight cars are higher than either passenger cars or locomotive stacks. The extreme clearance requirement is for height, top of rail to running board, of highest car, height of brakeman added thereto, and a further allowance for contingencies, among which may be height of load of light material on an open car exceeding maximum box car height.

There are, at the present time, on the railways of standard gauge in the United States, Canada and Mexico,* about 2,377,282 freight cars of all kinds. They classify as to height, rail to running board, as follows:

Under 12 ft. including flat, gondola and tank cars.	63.1%
12 ft. to 12 ft.	23.4%
13 ft. to 13 ft. 6 in. inclusive.....	11.9%
13 ft. 6 in. to 14 ft. "	0.65%
Over 14 ft.	0.95%

Of the total number of freight cars 98.4 per cent. are 13½ ft. high or under, and only 1.6 per cent. are higher than 13½ ft; and less than one per cent. higher than 14 ft.

Considering main trunk lines, the Pennsylvania Railroad, Baltimore and Ohio, Erie, Lehigh Valley, Great Northern, and a number of others as far as known, i.e., with a small percentage of cars having dimensions not ascertained, among them the Grand Trunk and Canadian Pacific Railways, have either none or less than one quarter of one per cent. of freight cars over 13½ ft. to running board.

The Master Car Builders' Association, whose rules and standards are adopted by railways on the North American continent generally, and recognized by the Board of Railway Commissioners for Canada, although it has not fixed a standard for box car dimensions, adopted in 1904, as recommended practice, a height of 12 ft. ¾ in. to eaes, equivalent to less than 13 ft. height to running board. High standard cars are such as the Grand Trunk Pacific Series 300000-310824, 13 ft. 4 in., and the Canadian Pacific new steel frame box cars Series 130000-132998, 13 ft. 4¾ in. The highest regular Canadian Pacific freight cars are 13 ft. 6 in. to running board and this may be said of most of the main trunk lines of railways. The highest Pennsylvania Railroad freight cars are 13 ft. 4 in.

Limits of car dimensions are fixed by clearance outlines on the various railways. A composite clearance limit diagram for ninety railways*, including all Canadian trunk lines, has height of 14 ft. 6 in., limiting "overall" height of cars to this figure and practically limiting height to top of running board of freight cars to 14 ft. In the St. Clair tunnel, Grand Trunk Railway, the clearance height at width of 3 ft. is 14 ft. It is true that on many divisions or branches of the lines considered the clearance is somewhat greater than shown in the composite diagram referred to; on the other hand, it is less on a number of main lines and on many branch lines.

*Official Railway Equipment Register..

An empty freight car 14 ft. high will on 5 ft. (out to out of rails) transverse base not resist a 30 lb. wind pressure when standing alone.

The limit of grade, approaching crossings, can, for railways, be taken as between 5/10 of one per cent. and one per cent. For city streets a grade of 5 per cent. is in most cases extreme and should be for main country highways, and it should be short at that. A preferable maximum grade for roads is 4 per cent., and 3 per cent. is materially better. This works out as follows:

5% grade 20 x 2 = 40 ft. length of approaches for every vertical foot of clearance.

4% grade 25 x 2 = 50 ft. length of approaches for every vertical foot of clearance.

3% grade 33 ft. 4 in. x 2 = 66 ft. 8 in. length of approaches for every vertical foot of clearance.

Any gain, by curtailment of vertical clearance requirement, or by change of railway grade, or by both, means corresponding shortening of road approaches, and at their high ends. Such a gain of one foot may greatly reduce the cost of a given grade separation, may make it practicable while otherwise it would not be; a vertical gain of two feet would mean a very large addition to the number of practicable grade separations.

As to brakeman on car 7 ft. must be accepted as the extreme allowance that should be made. 6 ft. 6 in. will clear any brakeman unless he should be over 6 ft. tall, and 6 ft. brakemen are not common, to say the least. What is to be said for the contention, seriously made, that the brakeman, on running board of highest known car, should be allowed room to swing his lantern over his head? The necessity for brakemen on tops of cars is becoming less and less, and has in many cases disappeared, rules and regulations of railway companies to the contrary notwithstanding. The air brake is now universally used in train control. In Canada orders of the Board of Railway Commissioners in force since December, 1908, provide that no regular freight train shall be allowed to proceed on its journey unless at least three quarters of the cars comprising it shall be equipped with air brakes in good working order, and that every freight car shall be equipped with air brakes and with operating levers on both sides of the end.

A stage arrives in the increase of traffic of railways when grade crossings become intolerable, and when the risk and interruption due to them becomes more expensive than their elimination. In Europe grade crossings in any considerable centres of population are the exception and this may soon be said also of main trunk line railways in the older of the United States. The Pennsylvania Railroad makes it a rule to avoid all grade crossings on new work and has within the last nine or ten years eliminated over 50 per cent. of its grade crossings on main lines. To do this clearance must be made as low as possible. Overhead bridges are as low as 16 ft. 6 in. above top of rail. Many are 18 ft. 6 in. and less. Twenty-one feet, the standard for signal bridges, is recognized as the highest clearance for which there can be any need. In New York many overhead bridges throughout the state are only 18 ft. above top of rail, and this is the case also in Massachusetts and in other States. The New York Central and Hudson River Railroad has asked for 16 ft. or

*Railroad Age Gazette.