of all but a very smail percentage of freight cars now in use, and that cars higher that 14 ft. to running board, i. e., higher than 14 ft. 6 ins. "over all" or to top of brake rod, can only to a limited extent traverse beyond their home railways. That higher cars will be economical or practicable is as little probable as that the gauge of railways will be widened or their entire structure changed. For a vertical clearance requirement greater than 21 ft. (14 ft. plus 7 ft), there can, in any event, be no conceivable rational need.

In Canada the Railway Act provides that every bridge over a railroad shall have a clearance of at least 7 ft. between the top of the highest freight car used on the railway and the lowest beams of the bridge, and that except with the approval of the Canadian Board of Railroad Commissioners, the clearance between the rail level and the overhead bridge shall not be less than $22\frac{1}{2}$ ft. It is understood that in this case the rail level is taken to mean the base of the rail instead of the top of the rail as is more customary. In passing on proposed grade separation in Toronto, the railroads asked for a clearance of only about 19 ft. in place of the standard $22\frac{1}{2}$ ft. The Commission in its decision dated Dec. 30, 1908, denies the request for a smaller clearance than $22\frac{1}{2}$ ft., arguing that it woul prove a serious menace to employes required to work on top of freight cars.

It was said the rule requiring men to go on the tops of freight cars in the Toronto yards could be abolished; different rules for different terminals would only lead to confusion. The Board's accident inspectors are being continually called upon to investigate accidents caused by lack of headroom under bridges, and lack of lateral space along the sides of engines and trains. Our officials have been steadily endeavoring to eliminate these sources of danger, and it is entirely out of the question that we should sanction the erection of overhead bridges from York street east, of a character different from that which the law calls for. There are now too many of these structures in various parts of the country, and instead of sanctioning more, it is the plain duty of the Board to endeavor to get rid of those that now exist.

In New York State the Public Service Commission for the Second District has insisted on a minimum clearance of 21 ft. An exception was made in case of electric zone of of the N.Y.C. & H.R.R.R. near New York City. After issuing an order with the consent of the company that brakemen should not ride on the tops of cars within this zone the Commission permitted clearances of 16 to 16¹/₂ ft.

TABLE OF MINIMUM CLEARANCE OF BRIDCES OVER RAILROADS IN GRADE SEPARATION WORK.

Canada, 22½ ft., except with approval of Board of Railroad Commissioners.

Toronto, 221/2 ft., Waterfront viaduct under order Railroad Commission, June 9, 1909.

Connecticut, 18 ft., Except with approval of the Railroad Commissioners, Connecticut Statutes S. 2018.

District of Columbia: Washington, 17 ft.

Massachusetts, 18 ft. Except with approval of State Railroad Commission

Brockton, Mass., 18 ft.

East Boston, Mass., 16 ft. In two cases 15½ ft., B. & A. R.R. Decree of 1904.

Newton, Mass., 16 ft.

Worcester, Mass., 18 ft.

New York State: 21 ft. 16 ft. to 16½ ft., within electric zone of N.Y.C.&H.R.R.R. near New York City.

Buffalo, N.Y., 16 to 18 ft. In a few cases 15 ft. N.Y.C. R.R. Belt Line 21 ft.

EARTH PRESSURES.*

CHARLES K. MOHLER, M.W.S.E.

A study of the sliding prism theory of Vauban after the graphics of Rebhann and of the analytical theory of Rankine, showing lack of agreement, and break-downs in the theories when worked out for results; also formulae and results from a new method.

There is no department in the whole field of engineering which can be charged up with so great a proportion of failures or partial failures as that relating to the design and construction of abutments and retaining walls. Until very recently there has been almost no progress made in designing structures of that class that will stand up without showing signs of weakness or failure.

While we are greatly in need of more reliable and exact data relating to earth pressure than we now possess, there is one erroneous dogma, which we should lose no time in



Fig. 1.—Characteristic Settlement Crack, Due to Excess Toe Pressure.

getting away from absolutely. That is the old text-book statement that "If the wall is designed so that the resultant of the forces acting on the base, cuts the base inside the middle third the wall is safe against overturning." Under some conditions nothing could be much farther from the truth. Unless we are to be satisfied with a tipped and cracked wall, it is a safe rule for only one condition; that is where there is a rigid and unyielding foundation such as solid rock. Unfortunately rock foundations are the exception rather than the rule for ordinary walls.

With a compressible or yielding foundation you cannot expect anything but a cracked or failing wall when the foundation reaction at the toe of the wall is greatly in excess of that at the heel, which the middle-third theory allows and usually gives. Piling is often used to correct the evil and

*Presented April 6, 1910, before Western Society of Engineers.