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For THE CANADIAN ENGINEER.

RAILWAY ENGINEERING.*

BY CECIL B. SMITH, MA. E., MEM. CAN. SOC. C.E., ASSISTANT PROF. OF CIVIL ENGINEERING IN M'GILL UNIVERSITY.

CHAPTER III.

CURVES—(*continued*).

ARTICLE 8—VERTICAL CURVES.

Wherever there is a change in the rate of grade there must be a vertical angle or a vertical curve. If this change is slight, less, say, than $\frac{3}{10}$ feet per 100 feet, no need exists, either on construction or afterwards, of doing anything more than to let the trackmen put in a slight curve by eye, but when the change is of considerable magnitude, care should be taken, both for the sake of appearance and also for safety, that a regular vertical curve unites the two grade lines.

In the past, in America, this has not been often done. If ascending and descending grades were to be united, a short piece of level grade was inserted at the summits and in the depressions; anything further was, curiously enough, relegated to the track gang as being a refinement unnecessary for a civil engineer to bother with; the track or section foreman, with greater appreciation of the real need for a regular increment of change from one grade to another, did the best he could and put in vertical curves by eye, which moderated the ill-effects of such neglect. Wellington has ably dealt with the subject, at length, from the standpoint of the link-and-pin coupler, and demonstrates that the vertical curve which is needed, theoretically, is one which will change the rate of grade from the front to the rear of the longest trains run over the road by an amount not greater than the grade of repose (the grade of repose is that grade down which a train will just keep moving under its own weight, and is about $\frac{5}{10}$ per cent. for loaded trains at a speed of 25 miles per hour, and increases with the speed). He reasons thus: Taking the train as a whole, each car will momentarily crowd toward the one in front of it, and so on throughout the whole length of the train, putting it in a state of compression, with slackened couplers if the grade resistance at the front of the train is enough greater than at the back end to exceed the grade of repose. This is based on an assumption of uniform engine power, and should the engine driver increase speed just at this instant, when everything is slack, the tendency will be to create severe jerks and oscillations causing derailments. This reasoning refers entirely to a grade depression, whereas at a summit the reverse will happen and the couplers will be momentarily strained much more than normally. From these premises we can see that the vertical curve at summits may be arbitrary in amount and much sharper than in depressions. Probably a change in rate of grade of $\frac{2}{10}$ per cent. for each 100 feet is not excessive, and may be inserted either as a complete curve joining the ascending and descending grades (see Fig. 8), or if the summit level is long it may be divided into two portions (see Fig. 9). When, however, a descending grade is to be

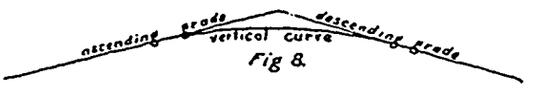

Fig 8.

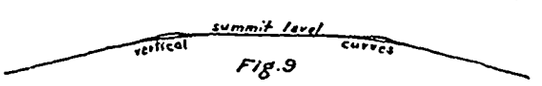

Fig. 9

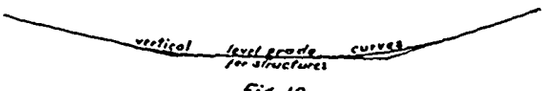

Fig. 10.

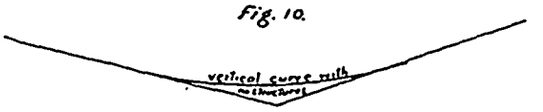

Fig. 11.

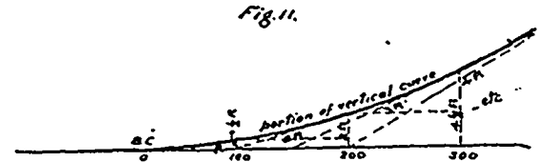

Fig. 12.

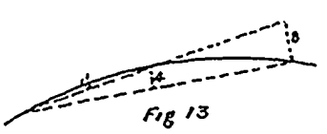
Fig 13

united to a level or ascending grade, an accurate calculation should be made for reasons already given. For in-

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