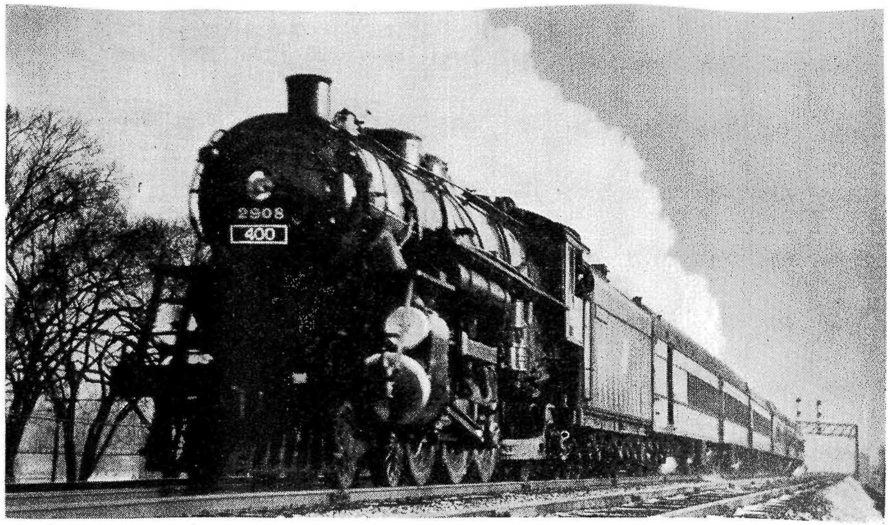
Railway Signaling

Chicago & North Western makes tests on which to base signal spacing for new higher-speed trains



Stopping Distance *and* Signal Spacing

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WITH the modern tendency for higher speeds and greater weight of trains and the direction of their movements by signal indications and automatic speed control, it became necessary on the Chicago & North Western that some accurate data be secured with reference to train braking and stopping distances. A study of braking efficiency for various types and weights of equipment was made and, after confirming tests had been made, a braking curve was laid out for various typical trains.

Referring to Chart I, the top curve represents calculated values for passenger train braking. The middle and the bottom curves show results of the actual testing of a certain type of locomotive with a definite make-up of passenger train. These test trains were actually operated to secure full service stopping distances at measured speeds on typical grades, more than 15 actual test stops being made to secure the data for each curve.

It is interesting to note that the curves based on actual field tests generally conform to those based on calculation, varying only because of the increased weight of train. The notes on the chart are self-explanatory and those relating to grade corrections are only approximations. The most interesting data are those represented by the points in circles, representing actual road tests of two classes of passenger trains, capable of speeds of 90 to 100 m.p.h.

The test of a regular passenger train of the 90-m.p.h. class, known as "The Pacemaker," operating a light engine with three standard steel coaches and stopping in 4,700 ft. from a 75-m.p.h. speed, practically coincides with the calculated curve for a similar train and is practical assurance that the calculated curve is correct.

"Pacemaker" and "400" Tested

The three tests of a regular passenger train of the 90-m.p.h. class, known as the "400," with six and seven heavy steel parlor-type cars stopping in the distance shown, from the speeds as shown, practically assures that these distances are less than contemplated. It is to be noted, however, that the "400" type trains operate with more wheels and this is apparently reflected in the reduction in stopping distances.

It should be noted that the tests are in the range above 70 m.p.h. and, in general, conform to the estimates of stopping distance as shown by Chart I.

Referring to Chart II, which has similar data as to stopping distances for freight trains: It will be noted that the calculated curves very closely conform to the curves plotted from a series of actual road tests made under varying conditions of speed and grade. Freight train speeds on this railroad are limited to 50 m.p.h.

Spacing Based on Weight, Speed and Headway

With these data, signal spacing is based upon the greatest train speed for the heaviest train operated, together with the desired headway. In general, with three-aspect, two-block indications for high-speed trains, it is not only desirable to space signals to provide safe stopping distance but also to keep a signal in view at all times. Enginemen driving these high-speed trains like to pick up the next signal as soon as possible after passing one.

Since these stopping distances represent actual tests which include the variables, such as weather, human reaction and possible delay in the brake apparatus, 10 per cent variation in speed or distance is considered sufficient. With the speed limitation of 50 m.p.h. or less on freight trains, the basic consideration in the high-speed passenger train districts is the movement of such trains. The additional safeguards in signal spacing are represented by the sighting distance, which suggests color-light signals, and by the further fact that passenger-train stopping distance can be further reduced by an emergency application of the brakes even after a service application has been made.

In districts where close headway is not a factor, three-position signals spaced 8,000 to 9,000 ft. are giving satisfaction, but in districts where slower trains may operate with close headway, four-position signals spaced 4,000 ft. will permit following movements at a speed of 40 m.p.h. by rule, and still provide an unrestricted movement of the fast trains with clear block protection spacing of 8,000 ft. or more.

Closing in on junction points or in terminal zones where signals must be spaced less than 4,000 ft., it is often more advisable to adopt the scheme of using a double approach indication, which causes no restriction to fast trains when a block is clear and permits other close movements at a speed not to exceed 30 m.p.h. by rule, when another train is ahead. At certain special places, consideration is also given to the proposition of overlapping when, because of physical conditions, it is almost essential that signals be spaced only 6,000 to 7,000 ft. in a district where 8,000 to 9,000 ft. is called for.

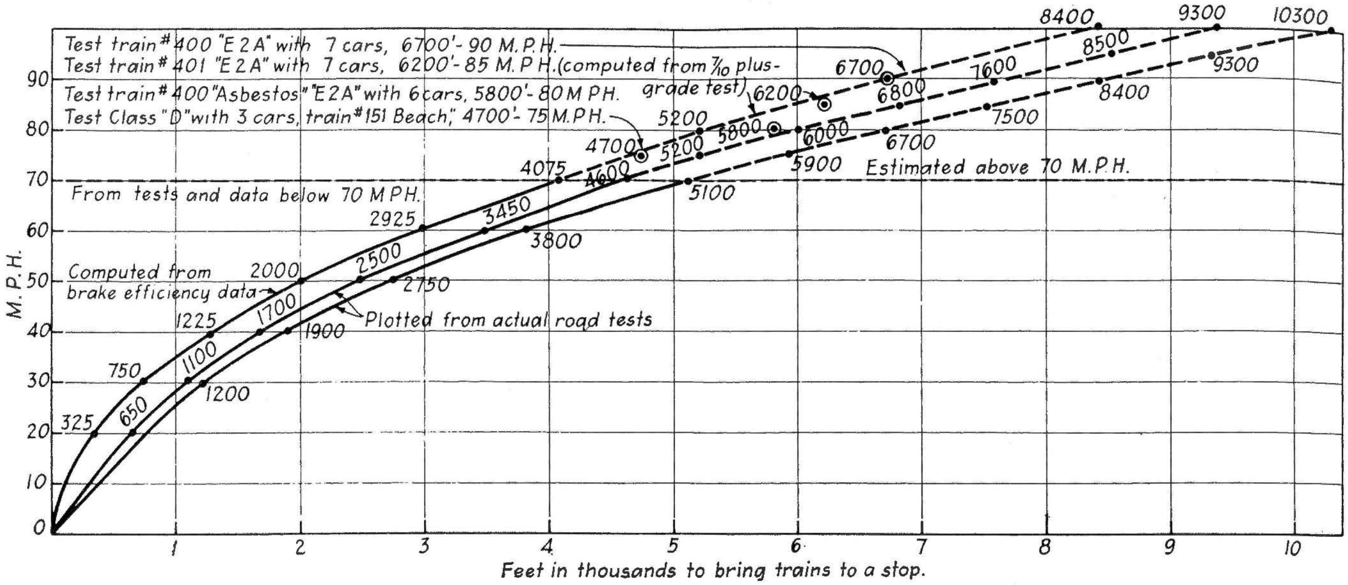

Chart I—Passenger train stopping data obtained from C. & N. W. tests—Full service application until stopped, at zero grade

Top Curve—Class "E" locomotive with three 50-ton passenger cars totaling 150 tons plus 297-ton locomotive.

Middle Curve—Class "H" locomotive with twelve 50-60 ton passenger cars totaling 690 tons plus 410-ton locomotive.

Bottom Curve—Class "H" locomotive with twenty 50-60 ton passenger cars totaling 1,106 tons plus 410-ton locomotive.

Class "D" locomotive weighs 162 tons.

Class "E2" locomotive weighs 243 tons.

Class "E2A" locomotive weighs 286 tons.

Passenger cars of Train "400" average 70 tons.

Notes: Grade correction approximately 1.5 per cent less for plus 0.1 per cent grade and 2 to 3 per cent more for minus 0.1 per cent grade.

Distance for stopping with emergency application 50 per cent less at high speeds; service emergency less than full service.

Class "E2A" locomotive with train "400" shows better braking tendency, evidently due to 12-wheel tender and 12-wheel cars.

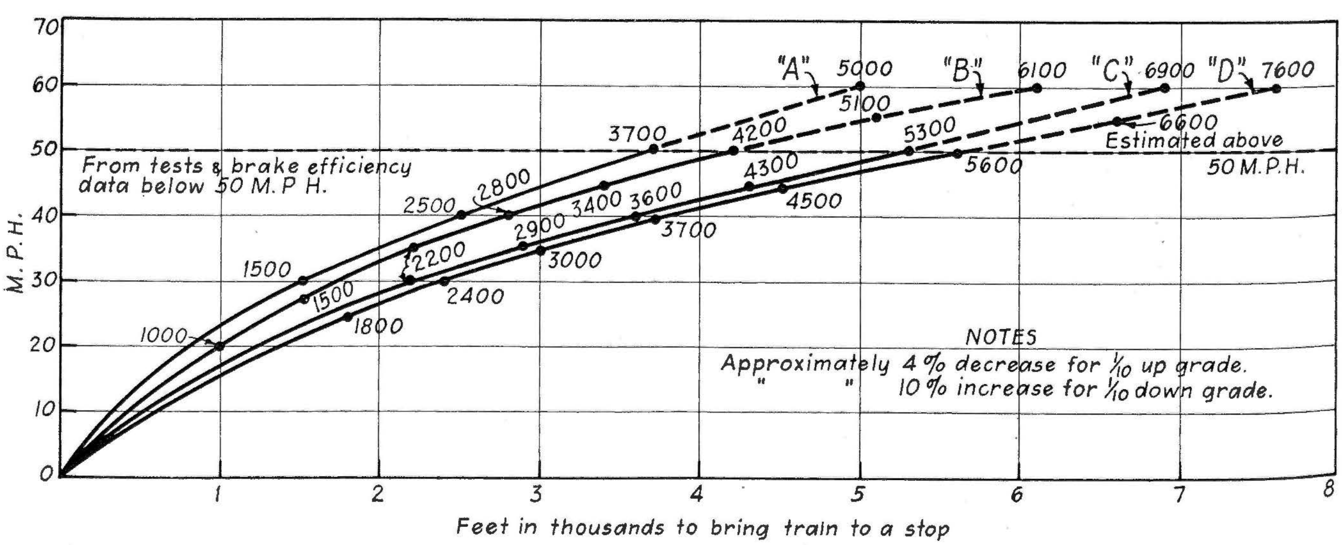

Chart II—Freight train stopping data obtained from C. & N. W. tests—Full service application until stopped, at zero grade

Curve "A"—Class "J" locomotive weighing 235 tons with 50 cars—1,500 tons. Computed from brake efficiency data.
Curve "B"—Class "H" locomotive weighing 410 tons with 33 loaded cars and 11 empties—2,000 tons. From actual road tests.
Curve "C"—Class "J" locomotive with 40 loaded cars—3,073 tons. Computed from brake efficiency data.
Curve "D"—Class "H" locomotive with 44 loaded cars and 2 empties—3,860 tons. From actual road tests.
Note: Approximately 4 per cent decrease for plus 0.1 per cent grade and 10 per cent increase for minus 0.1 per cent grade.