PROCEDURE EMPLOYED IN ANALYSIS OF PASSING DISTANCES

By E H Holmes, *Highway Engineer-Economist*
U. S. Bureau of Public Roads

(In Abstract)*

Studies of passing distances, both by analytical and experimental methods, have frequently been undertaken, and their results have been useful Yet it is believed that none of these studies, generally confined to the mechanics of passings, has been sufficiently exhaustive in its nature to answer all the questions the highway designer should ask It is not difficult to determine the distance required for one vehicle to pass another under various conditions of speeds of the two vehicles, but the results are of little value unless the frequency of occurrence of passings is known, and whether, for example, the majority of passings are accomplished not singly, but in groups A comprehensive analysis of passing practices must, therefore, be built around the following specifications as an absolute minumum

1 The study must be conducted in the field

2 The study must include only the normal traffic Test drivers or test vehicles cannot be employed in determining normal passing practices

3 All the units of the traffic stream must be observed, and their progress recorded continuously

4. The section over which the study is conducted must be of sufficient length to permit the completion of any normal passing maneuver.

5 Since observation of normal driving practice is required, the work must be so distributed geographically that all differences in driving habits are included.

In the development of a method satisfying these requirements, half-mile sections of roadway were selected Detectors placed in each traffic lane at 50-ft. intervals were used to record the progress of all vehicles as they traversed the section, each detector being connected by a cable to an individual pen of a graphic time recorder. This recorder marked the time at which each passing vehicle actuated successive detectors in the particular lane in which it was traveling. Since this strip chart moves at constant speed, the rate traveled by a vehicle over any 50-ft section required only that the distance on the chart between the marks made by successive pens be scaled and converted to speed

The half-mile of highway was divided into three independent sections, within each of which the detectors were connected to a single 40-pen recording unit, thus making it desirable that the recording units be located at three separate points While the two charts in a single unit were constantly synchronized by the mechanical coupling between the two recorders, it was necessary to synchronize the three units by means of a single master clock in series with a pen in each of the six recorders This clock automatically closed a circuit and actuated the six pens at 10-sec intervals, while the time of day was recorded in code by means of a telegraph key in the same circuit, at intervals of two or three minutes

For the detectors, a design employing an air switch and rubber tube was adopted As a vehicle passed over this tube, the air displaced by the wheels actuated the diaphragm and closed a circuit leading to the time recorders. An air switch was attached at each end of the tube, and holes punched in the middle prevented the air impulses from

* Reported fully in *Public Roads*, January, 1939

passing the midpoint of the road. Each air switch was therefore actuated only by the vehicles in the traffic lane nearest the switch.

An interesting feature of the detector was the means by which the electrical circuits were conducted from the air switches to the recorders There were, of course, two leads from each air switch The negative leads from the switches on the side of the road opposite the recording equipment were connected to a single wire running the length of the section and serving as a common return The positive lead from each of these switches was returned by a wire installed inside the tube to the side of the road near the recording equipment, and was there incorporated in the cable leading to the time recorders The entire unit, including the tube and the two air switches enclosed in ordinary tin cans for protection from the weather, cost less than $4, and could be wound into a small coil when not in use When installed at 50-ft intervals on a concrete road the tubes resembled expansion joints, and were barely visible on bituminous surfaces

Finally, to connect the road switches to the time recorders, some 50,000 feet of wire was made up into six cables, one cable to run in each direction from each recording unit To the detectors at the ends of the section ran three wires, two for the positive leads and a common return for the negative lead to the switch on the near side of the road While the common return was tapped at each detector, two wires for the positive leads were added to the cable at 50-ft intervals until it consisted of 19 wires for the road switch circuits as it reached the recording equipment The recording units were connected by four more wires that were incorporated in the cable Two of these wires were for the circuits for the synchronizing clock, and two were for the

TABLE 1

SAMPLE DATA FOR TWO SIMPLE VEHICLE PASSINGS

Item		Passing	
		No 1	No 2
Speed of passed vehicle before the passing	miles per hour	26 2	26 2
Speed of passing vehicle before the passing	miles per hour	32 0	31 0
Maximum speed of passed vehicle during the passing	miles per hour	29 1	27 3
Maximum speed of passing vehicle during the passing	miles per hour	37 9	37 9
Speed maintained by passed vehicle after the passing	miles per hour	29 6	23 5
Speed maintained by passing vehicle after the passing	miles per hour	42 6	37 9
Speed difference before the passing	miles per hour	5 8	4 8
Maximum speed difference during the passing	miles per hour	8 8	10 6
Speed difference after the passing	miles per hour	13 0	14 4
Distance passing vehicle straddled center line in beginning passing	feet	100	50
Distance passing vehicle traveled entirely in left lane	feet	400	200
Distance passing vehicle straddled center line in completing passing	feet	350	100
Distance passing vehicle encroached in left lane	feet	850	350
Time passing vehicle encroached in left lane	seconds	15 4	7 0
Speed of approaching vehicle	miles per hour	[1]	34 1
Distance between passing vehicle and vehicle approaching from the other direction immediately before passing	feet	[1]	792
Distance approaching vehicle traveled during passing	feet	[1]	349
Clearance between passing and approaching vehicles at completion of passing	feet	[1]	93

[1] None involved

telephones used in communication between the three units The common returns on the two sides of the road were connected by a wire laid across the pavement The single return wire mentioned previously, with the leads accurately spaced at 50-ft intervals, was normally laid first, pulled taut and spiked at both ends By using these leads in spacing the detectors, it was not necessary to measure the sections before or during installation

In a simple passing the two vehicles engaged in the maneuver are first recorded on the chart for the right lane As the second vehicle draws left to begin passing, its progress is charted on both recorders while it straddles the center line Soon it moves completely into the left lane and its progress is noted only on the recorder for that lane, where the pens are actuated in reverse order After having passed the first vehicle, the passing vehicle is recorded again as it straddles the center line in returning to its own lane, and finally, as it draws away from the vehicle just passed, it again is recorded only in the right lane Meantime, the passed vehicle has been maintaining its course along the right lane, and the effect of the passing on this vehicle may readily be observed by determining whether it accelerated, decelerated, or continued at the same speed while the other vehicle passed and drew away

Figures in the Table 1 were summarized from the transcribed data from two simple passings In each simple passing there are four major variables, three of them—the speed of the passed vehicle, the speed of the passing vehicle and the speed of the approaching vehicle, if any—being independent variables, while the fourth, the dependent variable, is the distance required for completion of the maneuver In addition there are, particularly in multiple passings, a large number of minor variables

With respect to the relative importance of the various phases of the analysis, it should be apparent that the times and distances involved in individual passings are of minor importance It is true that in the design of highways, distances required to pass under the various conditions normally encountered must be known in order to provide the required sight distances, but these distances are those needed in the design of the structure and add but little to our knowledge of the effectiveness of the highway in providing for the free movement of traffic

For interpreting the effectiveness of the highways as a medium of transportation, however, it is likely that information on the time required to pass, rather than the distance in which the passing is completed, will be of major significance, for it becomes increasingly evident that the time spacing of vehicles may follow some rather definite laws Accordingly, a correlation between the time required to pass and the time spaces normally available in the opposing traffic lane will yield almost positive information with respect to highway capacity.

But it is of far. greater importance, in the analysis of the entire problem of vehicular movement, to understand, rather than the elements of time and space involved in these individual or multiple passings, the behavior of the driving public It is necessary to examine closely how passings are accomplished and in what number they may be expected, whether there is a preponderance of single passings, or whether the majority of passings are accomplished by groups of vehicles passing other groups, and whether the alinement of the highway itself perhaps has a greater influence on the passing practices than do the psychology and desires of the individual drivers found in normal highway traffic

It will be evident that data collected in these field studies permit a variety of analyses quite distinct from this one particular use