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professionals

Founded in 1917
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exchange

TRAFFIC ENGINEERING HANDBOOK 6TH EDITION

Institute of Transportation Engineers

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The Institute of Transportation Engineers (ITE) is an international educational and scientific association of transportation and traffic engineers and other professionals who are responsible for meeting mobility and safety needs. ITE facilitates the application of technology and scientific principles to research, planning, functional design, implementation, operation, policy development and management for any mode of transportation by promoting professional development of members, supporting and encouraging education, stimulating research, developing public awareness, exchanging professional information and maintaining a central point of reference and action.

Founded in 1930, ITE serves as a gateway to knowledge and advancement through meetings, seminars and publications, and through our network of nearly 17,000 members working in more than 92 countries. ITE also has more than 90 local and regional chapters and more than 130 student chapters that provide additional opportunities for information exchange, participation and networking.



Institute of Transportation Engineers
1099 14th Street, NW, Suite 300 West
Washington, DC 20005 USA
Telephone: +1 202-289-0222
Fax: +1 202-289-7722
ITE on the Web: www.ite.org

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Table 4-5. Speed Study Data.

Vehicle Number	Travel Time t (sec.)	Speed (ft./sec.)
1	64.8	5,280/64.8 = 81.5
2	73.9	5,280/73.9 = 71.4
3	61.2	5,280/61.2 = 86.3
4	59.8	5,280/59.8 = 88.3
5	66.4	5,280/66.4 = 79.5
6	68.4	5,280/68.4 = 77.2
7	72.0	5,280/72.0 = 73.3
8	63.9	5,280/63.9 = 82.6
9	67.6	5,280/67.6 = 78.1
10	67.2	5,280/67.2 = 78.6
Total	665.2	796.8
Average	665.2/10 = 66.5	796.8/10 = 79.7

$$SMS = \frac{N(d)}{\sum_{i=1}^N t_i} = \frac{10(5,280)}{665.2} = \frac{52,800}{665.2} = 79.4 \text{ ft./sec.}$$

$$TMS = \frac{\sum_{i=1}^N \frac{d}{t_i}}{N} = \frac{796.8}{10} = 79.7 \text{ ft./sec.}$$

Traffic engineers also use several other types of speed measurements to describe and assess traffic conditions. Among others, these include *average travel speed*, *average running speed*, *operating speed*, *percentile speed* and *pace speed*. Average travel speed and average running speed are both types of SMS that take into account time spent while both moving and stopped. In contrast, running speed includes only time spent in motion. Thus, running speed does not account for any travel delay incurred while stopped.

Operating speed is commonly recognized as the speed at which drivers are observed operating their vehicles during free-flow conditions. Percentile speeds are speeds at or below which a specified percentage of traffic is traveling. The 85th-percentile speed is the most frequently used measure of the operating speed and is often considered the maximum reasonable speed of a traffic stream under the geometric and control conditions. As a result, it is used to establish posted speed limits for segments of roadway. The *pace* refers to the speed range (typically 10 miles per hour [mph] or 16.1 kilometers per hour [km/hr.]) that contains the greatest number of vehicle speeds compared to all other corresponding range intervals. The *pace speed* is a single number that refers to the highest speed within the pace.⁶

6. Density and Occupancy

The third fundamental traffic parameter is traffic stream *density*. Density—also known as *concentration*—is a measure of the longitudinal spacing of vehicles in a traffic stream. It is somewhat analogous to time headway, although spacing in terms of density is measured spatially rather than temporally. Density is of interest to traffic analysts because it can influence road safety as drivers maintain adequate spacing to brake and perform other evasive maneuvers. It also affects quality of service because drivers assess flow quality in terms of their ability to maneuver freely within lanes of freeway, weaving area, or ramp segment.

Density is related to vehicle distance headway. Distance headway is a measure of the distance from the front of a leading vehicle to the front of a following vehicle at an instant in time. As such, it includes both the length of the lead vehicle as well as the gap length between the two vehicles. Density can be estimated by determining the average distance headway of vehicles on a segment of roadway. For example, the density for a traffic stream with an average distance headway of 120 ft. per vehicle would be: