THE RELATIONSHIPS BETWEEN SPEED, SPEED LIMITS, AND MOTOR VEHICLE ACCIDENTS
An Annotated Bibliography

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September 1974
This bibliography is intended to be of use to anyone interested in the relationships between speed, speed limits, and accidents. It resulted from a literature search initiated in connection with the controversy regarding the safety benefits of the national 55 m/h speed limit. By using the resources of the HSRI Library, we identified some 100 publications on the subject issued since the 1960 Highway Research Board bibliography on motor vehicle speeds. These were read for their relative significance, and notes on the authors' conclusions were prepared for the more important articles and reports. Those annotated publications are listed chronologically in Part I. Part II lists all of the publications reviewed.

In general, the research literature shows that lowered speed limits reduce (1) the number of vehicles traveling at high speeds; (2) the mean speed of traffic; (3) the dispersion of speeds about the mean; and (4) the number of serious- and fatal-injury accidents. Since 1964, when Solomon described the relationship between pre-accident speed and accident involvement rate as a U-shaped curve, speeds significantly higher or lower than that of the traffic stream have often been cited as associated with high accident rates. It is evident from this survey, however, that existing data do not contain sufficient detail concerning the pre-accident situation to clearly define the causes of accidents or to suggest countermeasures that might prevent them.

J.E.H.
K.W.
PART I
SELECTED REFERENCES WITH ANNOTATIONS


Lists and briefly describes publications on the subject of motor vehicle speeds as they relate to characteristics of drivers, highways, vehicles, traffic operations, and collisions. A state-of-the-art bibliography covering a period from the early 1920's through 1958.


Reports the results of a Bureau of Public Roads study of 600 miles of two-lane and four-lane rural highways in 11 states, drawing on 10,000 accident records and on observations and interviews with 290,000 drivers using those highways. The principal finding was that accident involvement rate as a function of travel speed is expressed as a reversed 'J', curving lower from 35 m/h down to 65 m/h, then rising with higher speeds.


Concludes that experimental imposition of a 40 m/h speed limit on selected main roads in the London area significantly reduced the number of injury accidents.


Cites study results showing that small upward changes in posted speed limits had little or no effect on driving speeds or accident rates.

Cites 1958-1959 autobahn accident experience as evidence that the imposition of a speed limit increases accidents by contributing to formation of long columns of vehicles closely following each other in the left lanes of expressways.


Concludes that imposition of an 80 km/h speed limit outside built-up areas in Belgium in 1959 brought no decrease in the number of accidents.


This author, The Reporter General for Theme VI of the Fifth International Study Week in Traffic Engineering, 1960, presents conclusions of his review of papers presented there, including some that accept data but challenge the conclusions some authors reached from it. Smeed's conclusions regarding studies of the effects of speed limits:

1. A high proportion of drivers do not limit their speeds...to accord with legal requirements.

2. In nearly all cases for which we have satisfactory data, a speed limit had a marked effect in reducing the higher speeds.

3. In cases where distribution of speeds was identical before and after the imposition of the limit, this may have been due to [inefficacy of] the signs or the measurements of speed.

4. Speed limits seem to have a marked effect in reducing fatal accidents in urban areas. They have much less effect on slight or damage-only accidents.

5. There is some evidence that motor cyclist and pedal cyclist fatalities are especially affected by speed limits.

6. The imposition of speed limits on a number of main roads, including motorways, seems to have had a favorable effect on road accidents.

Presents a method for determining the optimal maximum and minimum speed limits for a roadway, based upon the operation cost, time cost, and accident cost. Offered as a workable and more scientific method than the 85th-percentile-speed method.


Cogent discussion of unmanageability of typical passenger cars in emergency maneuvers at high speeds, and suggestions of means of influencing manufacturers to improve designs.


Reports the results and further analyzes the study previously reported by Prisk in 1959. Some of the conclusions:

The greater the variation in speed of any vehicle from the average speed of all traffic, the greater its chance of being involved in an accident.

Drivers of passenger cars having low horsepower had higher involvement rates than drivers of cars having higher horsepower, regardless of the other variables studied.

Nearly half of all accident involvements were either rear-end collisions or same-direction side-swipes. However, as travel speed increased, the proportion of these accident involvements decreased and the proportion of single-vehicle accidents increased. At 80 m/h, noncollision accidents constituted half of all involvements.


Concludes that there is a strong relationship between the rate of occurrence of accidents and the speed distribution on rural state highways; that accident rate is significantly higher in areas where the speed distribution curve is non-normal; and that it is reduced when the distribution is changed to a normal one.

Argues that effectively enforced speed limits of 50 m/h on freeways, 40 m/h on rural highways, 30 m/h on urban arterials, and 30 m/h on business and residential streets would save 25,000 lives per year in the U.S. Includes assumptions that appear reasonable, plus some unusual and interesting factor comparisons, such as fatalities per year plotted against fractions of present speeds.


Presents results of an experimental four-month imposition of speed limits in three counties. There were significant reductions in number of accidents, injured, and particularly fatalities. The effect on weekends and holidays was greater than on weekdays. The effect was greater on main roads than in local speed-limited areas.

Munden, J. M. *The Relation Between a Driver's Speed and His Accident Rate*. Road Research Laboratory, Crowthorne, Eng., 1967. 29p.

Concludes that there is a U-shaped variation of accident rate (for drivers) with changes in relative speed. The average-speed vehicle has the lowest rate, while the rates for very slow and very fast vehicles are high. However, the fact that 'fast' and 'slow' drivers have high accident rates does not in itself necessarily mean that relatively high and low speeds are the only direct cause of the situation. It may imply that driving speed is also correlated with certain other driver traits which are likely to cause accidents.


Reports mixed and somewhat conflicting conclusions from studies of speed limits and accident rates in several countries, and discusses reasons why this should be so.

Concludes that the speed limit markedly reduced numbers of cars traveling at high speeds on motorways; that accidents and casualties on motorways were reduced by about 20%; and that accidents on all-purpose roads were reduced by about 3.5%.


Reports that a California Division of Highways experimental study of posting lane-by-lane minimum speed limits on 4-lane, 6-lane, and 8-lane freeways revealed few if any beneficial results and showed some results definitely unfavorable to operation and safety—i.e., the differential limits induced more drivers to travel in left lanes and to pass on the right.


Concludes that on the Interstate system, as the speed of a vehicle varied from the mean speed of traffic, either above or below the mean, the chance of the vehicle being involved in an accident increased; that the level of enforcement had little or no apparent effect on the mean speed or on the accident experience of a study section; and that accident rates were by far highest at urban interchange entrance ramps.


This review of European studies conducted since Smeed's review in 1960 concludes that:

1. The introduction of a speed limit reduces the proportion of drivers who drive at higher speeds.

2. The introduction of speed limits in urban areas was followed by reductions in all severities of accidents in all countries for which information is available, with more marked reductions in more serious accidents.
(3) In non-built-up areas, the results of imposing a speed limit are mixed. In some cases, speed limitations are followed by decreases in accidents, but in other cases the results are inconclusive.


Presents a summary of published findings. Draws upon 162 publications.


Contains six papers in which traffic safety experts from six countries present evidence supporting their conclusions that speed limits reduce accidents.


Concludes that a speed limit of 100 km/h resulted in slightly fewer accidents than no speed limit on the same roads, and that a speed limit of 90 km/h resulted in a substantially lower number of accidents than a speed limit of 110 km/h on the same roads. A careful, detailed four-year study, with considerable control checks.


Concludes that the likelihood of being involved in an accident is increased by a factor of 10 if one is driving at speeds which deviate considerably (approx 15 m/h) from the mean speed of the traffic; that a large proportion of accidents on two-lane roads studied in Monroe County, Indiana, are initiated by left-turning vehicles or by vehicles entering the road; also, that the Computer-Sensor System is an excellent but expensive method of collecting data on traffic flow characteristics during accidents.

Concludes that as speed increases, the injury level increases; that injury levels increase with age; that occupants in heavier cars suffer less severe injuries; that wearing of lap belts decreases injury levels; and that females have less severe injuries than males at higher speeds.


Concludes that the best method of establishing maximum speed limits is based on 85th percentile of travel speeds. Includes detailed instructions for establishing such limits. Volume II is an extensive review of literature and contains a section on speed, speed limits, and accidents.


Equates accident involvement rates at different travel speeds with the rate of overtakings; demonstrates that the rate of overtakings is reduced much more by establishing a minimum speed than by reducing the maximum speed on two-lane roads; and recommends therefore that minimum speeds be established and enforced as an effective means of reducing accidents. Also offers several possible explanations for the U-shape of the accident-involvement/travel-speed correlation:

1) Slow drivers are hesitant and uncertain drivers and thus may be expected to be accident-prone, while fast drivers are accident-prone because they are inconsiderate, risk-taking adventurers.

2) Perhaps many low-speed accident involvements were counted on roads of low standards, so that the dangerous road is at fault—not the low speed.

3) Drivers involved in accidents might supply biased speed estimates to escape legal charges or insurance claims.

4) The fact that 21 per cent of accidents in the 1964 Solomon study did not report speed may result in an unknown bias.

Reviews results of speed-limit-imposition studies in Sweden, Germany, France, Britain, Finland, Portugal, Denmark, Austria, Canada, Belgium, and Switzerland. Concludes that the introduction of speed limits has usually altered the distribution of vehicle speeds by reducing the number of vehicles running at high speeds and thereby reducing the dispersion of the speed distribution. Concludes also that many of the speed restrictions have resulted in a reduction in accidents, although not all of the studies obtained data adequate for statistically indisputable conclusions; and that in no case did an increase in accidents occur that could not be explained by outside influences—i.e., increased traffic volume, etc.


Reports on the use of computer sensor sites in an Indiana highway study of vehicle speeds and accident involvements. Includes one conclusion that the accident involvement rate of vehicles moving slower than the mean traffic speed is greatly elevated by the inclusion of accidents involving vehicles turning off the road or slowed down preparatory to turning.


Concludes that the higher the speed the more severe the accident, and the higher the speed the more injuries per accident; that, however, below a pre-crash speed of 55 m/h, fatalities are independent of speed; at speeds over 55 m/h, fatalities per accident increase very sharply as speed increases.


Concludes that the lowering of the speed limit from 90 to 70 km/h reduced the total number of accidents by 18 per cent, property-damage
accidents by 15 per cent, personal injury accidents 24 per cent, and personal injuries 29 per cent. A controlled one-year study.


Cites problems which recommend caution when using relations between speed and accidents:

Practically no objective information on speed in accidents is available.

Only the impact speed, not speed before accident, can be estimated from vehicle damage information.

Two-vehicle accidents are treated as two involvements. Thus, if speed for each vehicle is given it will not be known whether a fatality or serious injury at low speed is due to the high speed of the other vehicle.

It is likely that low speed before an accident is due to the driver recognizing a danger.

There exists strong evidence (Cirillo, 1968; Munden, 1967; Solomon, 1964) that the relative speed of a vehicle to the average speed of traffic, rather than its absolute speed, is related to accident involvement.

Though no simple and reliable relationships exist between speed and accidents, relations between speed and accident severity or fatality risk are strong and consistent.
PART II
PUBLICATIONS REVIEWED

1959


1960


1961


1962


1963


1964


"Here Are the Proportions in Which the Severity of Collisions Increase with Vehicle Speed." [In French.] ONSER Actualites, v. 11, 1964, pp. 6-8.

1965


1966


Moses, R. *Safety and Our Highways; Peak Loads; Speed and Safety*. Triborough Bridge and Tunnel Authority, New York, Sep 1966. 11p.


1967


Munden, J. M. *The Relation Between a Driver's Speed and His Accident Rate*. Road Research Laboratory, Crowthorne, Eng., 1967. 29p.


1968


1969


1970


1971


Kovacik, B., and Bates, O. "Unsafe At What Speed?" Wheels Afield, v. 6, no. 7, July 1972, pp. 36-37, 40.


1973


1974


An Operational Evaluation of Truck Speeds on Interstate Highways. Maryland University, Department of Civil Engineering, College Park, Feb 1974. 118p.
ERRATUM

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The following citation was inadvertently omitted from page 18:
