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DEPARTMENT

COOPERATIVE
RESEARCH

Traffic Accidents
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in cooperation with the
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TRAFFIC ACCIDENTS

1. Freeway Fatalities, California Highways and Public Works (P. O. Box 1499, Sacramento, California), Vol.43, Nos. 5-6, pp. 20-23, May-June 1964.

In 1961 and 1962, 26.1 billion miles were driven on California freeways. Had this travel taken place on conventional roads and streets, 1.630 persons would have died. As it really happened, there were 802 persons killed.

Almost all of the fatal accidents, reported in a study by Roger T. Johnson of the Division of Highways Traffic Department, might have been avoided. The needlessness of the deaths incurred is substantiated by the major findings of Johnson's report which are summarized in this article.

Projections indicate that more than 2,000 fatalities have been avoided since 1949 through the use of freeways instead of conventional highways. As more miles of freeways are completed and opened to traffic, the possibilities for accidents should decrease.

One-half of all freeway fatal accidents are single-vehicle accidents in which the driver usually has no one to blame but himself. Nearly one third of all fatalities on freeways involve hitting fixed objects.

As has long been known, drivers between 19 and 23 years of age contribute disproportionately to both fatal accidents and total accidents. Drivers in this age group were involved in 20 percent of the freeway fatal accidents while comprising only 8 percent of all licensed drivers.

About 30 percent of the fatal accidents occur between 11 PM and 3 AM but only about 5 percent of travel occurs during these hours. The severity of accidents is known to be considerably higher during hours of darkness.

Of the drivers who caused freeway fatal accidents, 36 percent had been drinking, 17 percent had physical shortcomings (fatigue, sleepiness, illness, poor eyesight, etc.) and 7 percent were driving defective vehicles. In addition, some drivers were emotionally upset, and although the degree of psychic disturbance is not readily measurable, it was considered to be a factor in fatal accidents.

After analyzing the 660 freeway fatal accidents, it became apparent that driver errors and physical shortcomings play an important role in accidents which result in death.

2. Freeway Fatal Accidents, 1961 and 1962, Roger T. Johnson, Calif. Dept. of Public Works, Division of Highways, Traffic Dept. (Sacramento, Calif.) Nov. 1963, 30 pp. + App.

The accident and fatality rates for all California roads combined for the years 1961 and 1962 are as follows:

Road Type	Accidents per Million Vehicle-Miles	Fatalities per 100 Million Vehicle-Miles
Freeways	1.43	3.07
All other roads and streets	4.21	5.77
Rural state highways other than freeways	2.47	9.17

In 1962 there were 426 fewer people killed in California traffic accidents than there would have been if all the travel then taking place on freeways had been obliged to use conventional highways and streets. The freeway fatal accident rate rose from 2.29 in 1961 to 2.71 in 1962. This appears to be a matter of chance variability from one year to the next.

One-half of all freeway fatal accidents are single-vehicle accidents. There are more "Single-Vehicle hit fixed object" fatal accidents than any other type. Median barriers have reduced cross - median accidents. Of all freeway fatal accidents, 12 percent occur on ramps or involve ramp maneuvers. About 1/3 (30 percent) of all freeway fatal accidents occur between 11 PM and 3 AM. Drivers between 19 and 23 years of age cause 1/5 of all freeway fatal accidents. Drinking drivers cause 36 percent of the freeway fatal accidents. Driver errors and driver physical short-comings play an important role in freeway accidents.

3. An Analysis of Random Freeway Traffic Accidents and Vehicle Disabilities, Frank De Rose, Jr., Project Engineer, John C. Lodge Freeway Surveillance Project Traffic Division, Michigan State Highway Department. Highway Research Record No. 59, pp. 53-65.

The John C. Lodge Freeway Surveillance Project is being conducted on the John C. Lodge Freeway in Detroit, Mich., between the Davison and Edsel Ford Freeway Interchanges. The project is being conducted jointly by the Michigan State Highway Department, the City of Detroit Streets and Traffic Department, Wayne County Road Commission, in cooperation with the U. S. Bureau of Public Roads.

The study section is 3.2 mi, with television surveillance being accomplished by 14 remotely controlled television cameras. This section has such geometric features as portions of 6- and 8-lane divided, 9 on- and

9-off ramps, a reverse curve and grades. It has carried as many as 160,000 vehicles per day for both directions. The lane and speed signal controls have been in operation for 1½years and the television system for 3 years.

Figure 1 indicates the study section's special design features, location of cameras, lane signals, speed signs, and ramp signals.

Trained observers are on duty for a 14-hr period from 6:00 AM to 8:00 PM daily, except weekends and holidays. A general log (see appendix) is maintained as a permanent record of all vehicular incidents including accidents, vehicle disabilities, maintenance operations, and others such as motorists aiding distressed vehicles. This log contains all the data for this study and analysis of freeway incidents.

4. Center Strip Barriers Planned for California Freeways, Southwest Builder and Contractor (Iles_Ayars Publishing Co. 1660 Beverly Blvd., Los Angeles 26, California), Vol. 134, No. 2, pp. 46, July 10, 1959.

The California Division of Highways will install barriers in the center strip of some of the state's more heavily-traveled freeways as the result of newly-completed research into the problem of the infrequent but often deadly head-on freeway collision, State Highways Engineer G. T. McCoy reported recently.

New types of barriers, developed in a series of laboratory-controlled crash tests, will be installed shortly on sections of freeway in the Los Angeles and San Francisco Bay Areas.

The detailed freeway accident study is the first of its kind and scope dealing with highways which carry very heavy traffic volumes. It includes a statistical and engineering analysis of 8,000 accidents which occurred on 265 mi of various types of divided highways in 1956 and 1957, and a review of all 407 fatal freeway crashes in the last 3 years.

During the 3-year period from 1956 through, 1958, about 43 percent of the fatal freeway accidents involved only 1 vehicle. An overtaking or rear-end collision was responsible for 21 percent of the fatal accidents; and pedestrians, most of them illegally hitch-hiking or using the freeway as a footpath, were involved in 17 percent of the fatal mishaps.

About 19 percent of the fatal mishaps were the approach type. This includes crashes brought on by wrong-way drivers, as well as the dreaded head-on accident in which a car or truck hurtles the driving strip.

The crash tests which constituted the other phase of the Division of Highways study were conducted by structural and materials experts at the Division's research laboratory in Sacramento.

McCoy pointed out that a median barrier, to be an effective aid to safety, must meet very exacting requirements. It must, of course, prevent crossings of the center strip, but it must also absorb high speed impact and minimize possible injuries from crashes; and it must reduce the threat of a vehicle bounding back into the traffic stream.

The impact tests bore out, in general, the findings of the accident study showing that barriers installed at some locations in the past have not satisfactorily met all of these requirements.

Fifteen basic barrier designs were tested. One design was discovered which appears to be nearly satisfactory in all respects. This design utilizes ordinary chain-link fence, light steel posts and three 3/4-in steel cables. The cables are strung horizontally along the fence, if possible from natural anchor points such as structure abutments. Two of the cables are suspended about 30 in. above the ground, and the third is located along the bottom of the fence.

This type was the only design which permitted deceleration within the test car which would be tolerable to human occupants. Because of the cables give or deflect slightly when engaged in high speed impact, this design is only suitable for freeways where the dividing strip is at least 12 ft. wide.

For medians with a width of from 5 to 12 ft, the more effective barrier would be another design new to California highways. This barrier is made up of back-to-back steel guard rails attached to wooden blocks and posts. There is also a supplemental lower rail to prevent rigid parts of the car from hooking into the posts. The wooden blocking and posts and the lower rail tend to reduce the severity of collisions with the barrier.

5. Freeway Accidents, Karl Moskowitz. California Highways and Public Works (P. O. Box 1499, Sacramento, Calif.), Vol. 41 Nos. 3-4, pp 9-15, March-April 1962.

The average traffic volume on California freeways in 1959 was 35,000 vehicles per day, ranging from 4,000 to 210,000. This volume produced 8,800 million (8.8×10^9) vehicle-miles of travel involving 10,000 accidents in 1959. During the three-year period 1957-1959 (with mileage and travel increasing each year), there were 21,047 million vehicle-miles and 24,834 accidents. Because this is more experience than has been available in many other jurisdictions, it is thought that some facts regarding these freeways would be of interest.

The accident rate, injury-accident rate, and fatality rate on rural state highways other than freeways are about 2½ times as great as the corresponding rates on rural freeways. Urban freeways have a lower fatality rate, but a higher rate of nonfatal accidents than rural freeways.

Direct comparisons of urban freeway accidents rate with other urban arterials are almost impossible to make, mainly because data on urban arterials are so difficult to obtain.

The fatality rate on freeways was just half that on all other streets and highways, rural and urban.

If the 8.8 x 10^9 vehicle-miles of travel on freeways had been subject, the hazards encountered on ordinary roads and streets at the rate of 5.66 per 100 million vehicle-miles, they would have resulted in 497 deaths, instead of the 249 that did occur. In other words, freeways then operating in California saved about 248 lives in 1959.

It is very interesting to note that rear-end collision accounts for only one-sixth of the fatal accidents on California freeways in 1960. Here, of course, is one of the things that is different about fatal accidents. The rear-end or sideswipe is the most prevalent type of accident on freeways, but as the layman surmises, it is not often fatal.

Although trucks are involved in a small percentage of fatal accidents on freeways, they are involved in a disproportionate share of rear-end accidents.

Of the 43 fatal rear-end collisions on California freeways in 1960, trucks were involved in 21. In 11 accidents, a truck was hit from behind. Two of them involved stopped trucks, and eight of them involved trucks going very slow, well below any speed limit. Raising the speed limit would have no effect on their speed. In 10 accidents, a truck overtook the other vehicle and could not or 1 did not stop in time.

Freeways are comparatively safe roads, but they are not foolproof. Their principal advantage is the elimination of cross traffic conflicts. Two-thirds of fatal accidents on freeways involve only one vehicle. One-third of fatal accidents occur between midnight and 5: 00 AM while only one-twentieth of the travel occurs during those hours.

For a prudent driver, the probability of being involved in a fatal accident is very much less than the over-all statistics indicate, and the over-all rate is 2.26 fatal accidents per 100 m.v.m.

6. Accident Analysis of Freeway Interchanges, Yoshiaki Sadai. Traffic Engineering (2029 K St., N. W., Washington, D. C.), Vol. 31, No. 6 pp. 20-22, March 1961.

This study of accidents at freeway interchanges was made in an effort to develop suggestions for possible improvement in the concepts of geometric design of interchanges. Accident data were collected and analyzed for various interchanges, certain statistical comparisons were made, and a number of conclusions were drawn.

Two typical types of interchanges were chosen, the diamond and the 2-quadrant cloverleaf. Five examples of each were selected, in the San Francisco Bay area in Los Angles and in Sacramento.

The accident and traffic data were obtained from records of the California Division of Highways and from the city authorities in whose jurisdictions the interchanges are located. Design characteristics of the interchange were studied in detail from plans made available by the state, and the features of the Santa Clara Street, "A" street, First Avenue, and Madison Avenue interchanges were carefully studied at the sites.

From the analysis reported it can be concluded that from the standpoint of traffic safety:

1. Visibility is one of the most important factors that should be considered in the design of freeway interchanges.
2. The interchange designer should endeavor to maintain the principles of up-grade on-ramps, down-grade off-ramps, and freeways which overpass secondary roads.
3. In areas with frequent rainfall, the diamond may be a better design.
4. In the design of interchanges--especially of 2-quadrant cloverleaf attention should be given to adequate warning signs, road surfaces with high coefficients of friction, longer radii of ramp curves and adequate superelevation, and avoidance of trees and other obstructions which might reduce visibility or increase the severity of single car accidents.
5. Improved design of the intersection of ramps with cross streets, such as good roadway lighting, high friction road surfaces, good channelization, etc., might make the diamond type of interchange superior to the 2-quadrant cloverleaf, especially in urban areas and at locations where there is a large percentage of truck traffic. This conclusion is based on a rather small amount of accident data, it should be pointed out, and it is hoped that other studies can be made to verify the point.

7. Vallejo Freeway: Latest Survey Shows Marked Decline in Accident Rate, Charles A. Pivetti. California Highways and Public Works (P. O. Box 1499, Sacramento, California), Vol. 40, Nos. 7-8, pp. 25-26, July-Aug. 1961.

Freeways save lives. This has been substantiated by reports from all over the United States indicating that freeways are from two to five times as safe as conventional streets and highways. Studies of accident records before and after conversion of city streets to full freeway show a trend in accident reduction ranging from around 7.5 to 1.5 accident per million vehicle-miles.

Statistics compiled for the California state rural highways network for the year 1959 show a statewide accident rate on highways other than freeways of 2.39 accidents per million vehicle-miles, whereas the rate on freeways was only 1.00 accident per million vehicle-miles.

A review of accident records for that portion of US 40 passing through the City of Vallejo offers substantial evidence that development to full freeway is the most positive and predictable approach to accident reduction that the highway engineer may employ.

Prior to construction to full freeway, US 40 through Vallejo had five of the most accident-prone intersections in District X. Despite constant attention and continuing attempts to reduce accidents through channelizing intersections and signalizing with expensive, interconnected signal systems the 4.5-mi length of expressway with intersections at grade experienced 336 traffic accidents during 1955 and 1956. In these 2 yr there were 99 accidents involving personal injuries during 1955 and 1956, and 4 accidents involving fatalities.

During 1957 and 1958 Vallejo's section of US 40 was converted to full freeway.

The first 2 yr of full freeway operation, 1959 and 1960, revealed a 73 percent reduction in accidents--245 fewer accidents than during the 2 yr preceding construction. Of the freeway's total of only 91 accidents as compared to the expressway's 336, only 29 involved personal injury and only 2 involved fatalities.

Also, it should be pointed out that the reduction in number of accidents was concurrent with a substantial increase in traffic volume. The average daily traffic volume increased from 22,000 vehicles in 1956 to 29,000 vehicles in 1960. This means that the reduction in accidents per million vehicles-mile is proportionately greater than the reduction in the actual number of accidents: the 1955-56 rate was 4.75 accidents per million vehicle-miles, the 1959-60 rate was 1.07. This represents a reduction of 78 percent which indicates the freeway to be more than four times as safe as the expressway it replaced.

8. Freeway Traffic Accident Analysis and Safety Study, B. F. K. Mullins and C. J. Keese, Research Engineers, Texas Transportation Institute, A. & M. College of Texas, College Station. HRB Bull. 291, pp 26-78.

In 1958, the Texas Transportation Institute initiated a research project under the sponsorship of the Automotive Safety Foundation to determine the possible correlation between freeway accidents and specific geometric design features on urban freeways and to investigate methods of improving accident reporting. A report on the phase concerned with improving accident reporting procedures was published in the December 1960 issue of Traffic Engineering.

This study considered some 10,000 accident reports on 54 miles of freeways in the five largest Texas cities, covering from 2 to 5 years of data. The reports, obtained from the files of the various cities, were recorded on microfilm to facilitate handling. The collision diagrams were plotted on continous strip maps of each freeway showing the geometric and profile features to scale.

A study of the continuous collision diagrams for various freeways indicated that certain locations experienced higher accident frequency than other locations. Because certain locations experienced high accident frequency and others having the same apparent physical characteristics experienced low accident frequency, even with due consideration of the respective volumes, it was probable that some physical factor contributed to the high accident frequency, even with due consideration of the respective volumes, it was probable that some physical factor contributed to the high accident frequency. If this relationship could be determined a reduction in the number of accidents might be realized by improvements in design.

Concentrations of accidents generally involved the following design features: (a) major changes in vertical alignment (crests and sags), (b) freeway ramps, (c) freeway interchange elements (interchange intersections and frontage roads), and (d) fixed objects. This report covers studies of accident concentrations in relation to each of these design characteristics.

Concentration of accidents at crests and sags indicated that the requirements for visibility or sight distance is particularly important. Freeway traffic, regardless of volume, tends to travel in more or less compact groups or platoons. The headway between the vehicles is often very short. For safe operation, the trailing driver must have a view of the traffic, or vehicles, for some distance ahead of him in both his and/or the adjacent lane or lanes. This visibility distance is greater than the distance required by the criteria for stopping sight distance on 2-lane roadways.

Entrance or on-ramps on the 10 freeways experienced much higher accident frequency than the exit or off-ramps. There was indication that the sight relationship afforded both the on-ramp drivers and the freeway through-lane drivers was especially critical. All high accident frequency on-ramp locations involved poor sight relationships.

Off-ramps with large angles of divergence and especially those affording poor visibility experienced higher frequency among off-ramps.

Diamond interchange intersections contributed three-fourths of the 21 percent of all freeway accidents which occurred on the frontage road system.

Most of the frontage roads were continuous and two-thirds were one-way. The frontage road at the points where the ramps joined the frontage roads and the section between the two ramps (included because the frontage roads were continous) contributed only 2 percent of all freeway accidents. Practically all of the two-way frontage roads were at extremely low volume locations and afforded no accurate comparison with the one-way sections.

Much improvement is needed in the operational control of diamond interchanges. Their complexity coupled with inadequate operational controls probably contributed the accident frequency at these points.

Twelve percent of the freeway accidents involved fixed objects. Such accidents caused 38 percent of all injuries and 65 percent of all fatalities. A large percentage of fixed-objects accidents occurred on the through-lanes and mostly at exit ramps. Medians (curbs and median barrier) were involved in one-third of the fixed-object accidents.

Early in the study it was discovered that the techniques used by enforcement officials in many cities in the investigation and reporting of freeway traffic accidents did not supply information adequate for proper engineering analysis. This inadequacy of reporting techniques seriously affected the progress and accuracy of correlations of accidents with design features.

The procedure developed in the early phases of the project to provide special freeway accident diagrams and the establishment of reference points along the freeway proved to be beneficial in improving the accuracy of reporting. The police departments reported greater ease in accurately locating and reporting freeway accidents.

Although few conclusive relationships were found between accident experience and specific design elements, inadequate sight relationship appeared to be a factor in all high accident frequency locations.

This study has emphasized the necessity of completely planning the study ahead of time, arranging for proper accident reporting, and obtaining necessary volume data during the study period for a most complete and accurate picture. The procedure of "looking back" followed in this study leads to a great deal of frustration brought about by inadequacy and inaccuracy in accident reporting.